The State of Inclusive Science Communication: A Landscape Study

Katherine Canfield and Sunshine Menezes

Metcalf Institute, University of Rhode Island

Graphics by Christine Liu

This report was developed for the University of Rhode Island's Metcalf Institute with generous support from The Kavli Foundation and the Burroughs Wellcome Fund.

Cite as: Canfield, K. & Menezes, S. 2020. The State of Inclusive Science Communication: A Landscape Study. Metcalf Institute, University of Rhode Island. Kingston, RI. 77 pp.

Executive Summary

Inclusive science communication (ISC) is a new and broad term that encompasses all efforts to engage specific audiences in conversations or activities about science, technology, engineering, mathematics, and medicine (STEMM) topics, including, but not limited to, public engagement, informal science learning, journalism, and formal science education. Unlike other approaches toward science communication, however, ISC research and practice is grounded in inclusion, equity, and intersectionality, making these concerns central to the goals, design, implementation, evaluation, and refinement of science communication efforts. Together, the diverse suite of insights and practices that inform ISC comprise an emerging movement.

While there is a growing recognition of the value and urgency of inclusive approaches, there is little documented knowledge about the potential catalysts and barriers for this work. Without documentation, synthesis, and critical reflection, the movement cannot proceed as quickly as is warranted. The University of Rhode Island's Metcalf Institute conducted a landscape study to address this gap and clarify the state of ISC with support from The Kavli Foundation. This document summarizes the findings from interviews of thirty ISC leaders whose work spans career stages, disciplines, sectors, and modes. The study also was informed by input from attendees at the 2019 InclusiveSciComm Symposium, the 2019 Society for the Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS) conference, the 2020 Advancing Research Impact in Society (ARIS) Summit, and informal conversations at other conferences held in 2020.

What are the key traits of inclusive science communication?

Inclusive science communication is fundamentally characterized by three key traits that must exist concurrently. While each trait is essential, any one of them alone is insufficient, and they are all linked by a common focus on equitable relationships.

1. Intentionality (e.g., regarding the audience, how "science" is defined, and how marginalized identities are, and have been, represented and supported)

2. Reciprocity (e.g., interactions between science communicators and audiences address past and present inequities through equal partnerships marked by co-creation and recognition of assets and varied forms of expertise)
3. Reflexivity (e.g., a continuous, critical, and systematic reflection on the communicators' and audiences' personal identities, practices, and outcomes, followed by adaptation as needed to redress inequitable interactions)

What are the study's novel insights?

- Disciplinary, sectoral, and modal silos are reinforced by language that practitioners and scholars take for granted.
- ISC leaders and newcomers, alike, feel a lack of belonging within the contributing disciplines and communities due to the hybridity of their approaches.
- Early career researchers and communicators bring a distinct suite of assumptions, concerns, and insights to ISC activities that could accelerate the field.

What are the major challenges for the movement?

- Disciplinary, sectoral, and modal silos (where "modes" refers to specific science communication methods or approaches, such as informal science learning in after school settings, museum exhibit design, science journalism, public engagement via social media, etc.)
- Silo-specific terminology poses barriers to broader understanding and collaboration
- Lack of widespread understanding of inclusive practices from individual to institutional levels
- Limited curricula and training to build ISC competencies
- Professional and financial risk for early career researchers attempting to pursue ISC careers
- Imbalanced representation among ISC leaders and throughout the movement
- Lack of institutional infrastructure (e.g., buy-in among administrators, incentives/reward structure, resources, funding) across academic and nonprofit environments

What are the pressure points that could stimulate or inhibit the ISC movement?

- Framing that invites all interested and relevant parties rather than reinforcing silos
- Spaces (virtual and in-person) for interdisciplinary and inter-modal collaboration and network building
- Support and amplification of early career researchers and communicators
- Creative approaches for evaluation and funding

Recommendations

1. Embed the key traits of ISC in all science communication practice as part of the effort to define and expand effective science communication
2. Embrace transdisciplinarity and intersectoral, intermodal expertise
3. Critically analyze language of practice and research to reflect ISC key traits and break down silos
4. Expand opportunities for multilingual engagement
5. Create and sustain in-person and virtual networks and resources for community building
6. Recruit and support diverse leadership
7. Develop, test, and evaluate inclusive science communication curricula and training
8. Develop new, collaborative approaches for evaluation of ISC practice
9. Value and validate context-dependent approaches to evolve beyond the binary concepts of "researcher" and "practitioner"
10. Funders use their influence to hasten ISC practices

This study marks the first investigation of motivations, methods, challenges, and pressure points for the inclusive science communication movement. While many of our observations have been noted in previous studies of the component disciplines, this new picture of the ISC landscape offers insights that can prompt a transdisciplinary view of these siloed but largely overlapping efforts. We hope this report can provide a basis for further exploration and experimentation that will dismantle the silos and accelerate the transition toward a new paradigm of science communication that is inclusive and equitable by default.

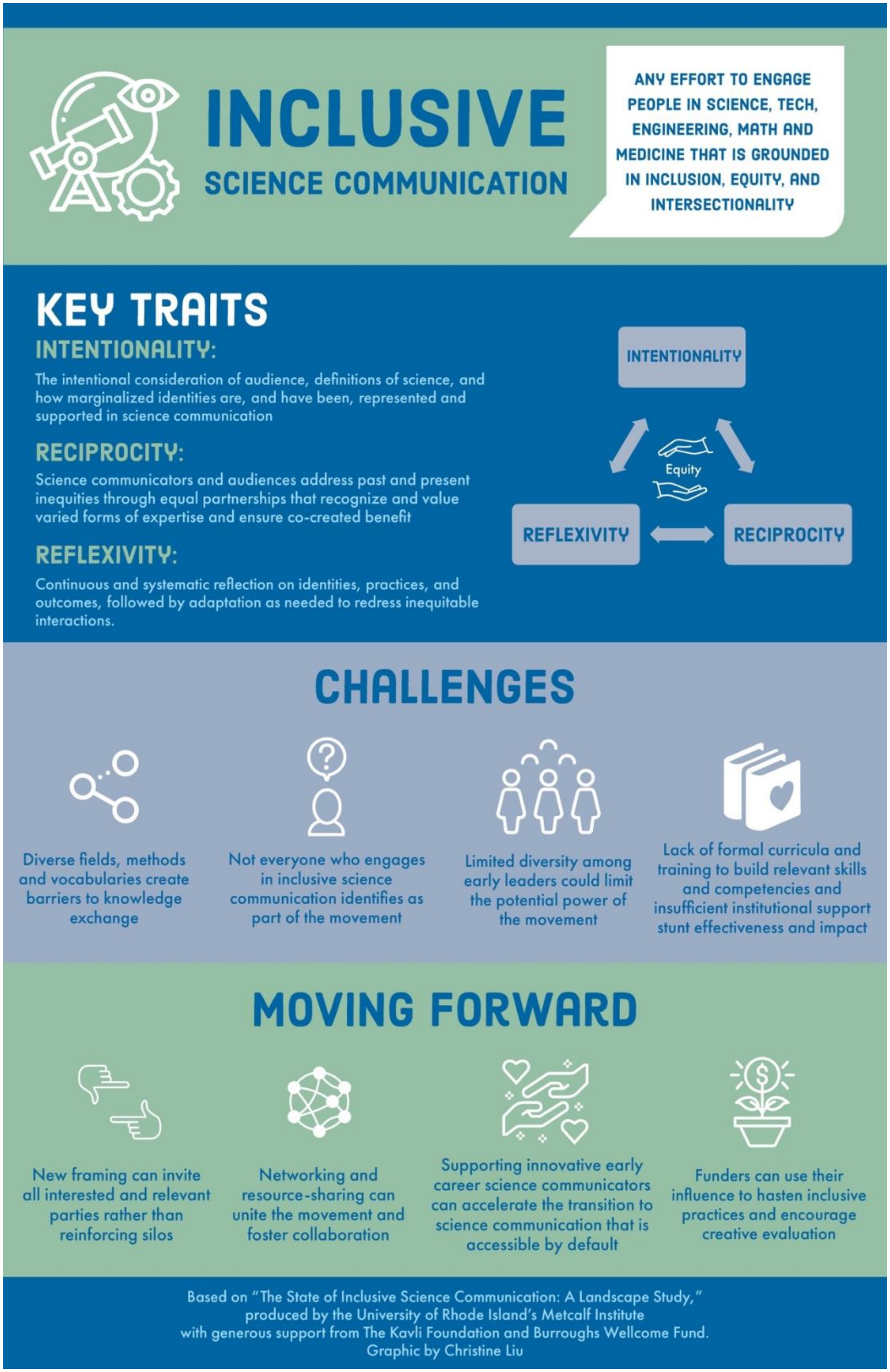
INCLUSIVE
SCIENCE COMMUNICATION
ANY EFFORT TO ENGAGE PEOPLE IN SCIENCE, TECH, ENGINEERING, MATH AND MEDICINE THAT IS GROUNDED IN INCLUSION, EQUITY, AND INTERSECTIONALITY
KEY TRAITS
INTENTIONALITY:
The intentional consideration of audience, definitions of science, and how marginalized identities are, and have been, represented and supported in science communication
RECIPROCITY:
Science communicators and audiences address past and present inequities through equal partnerships that recognize and value varied forms of expertise and ensure co-created benefit
REFLEXIVITY:
Continuous and systematic reflection on identities, practices, and outcomes, followed by adaptation as needed to redress inequitable interactions.
INTENTIONALITY
Equity
REFLEXIVITY
RECIPROCITY
CHALLENGES
Diverse fields, methods and vocabularies create barriers to knowledge exchange
Not everyone who engages in inclusive science communication identifies as part of the movement
Limited diversity among early leaders could limit the potential power of the movement
Lack of formal curricula and training to build relevant skills and competencies and insufficient institutional support stunt effectiveness and impact
MOVING FORWARD
New framing can invite all interested and relevant parties rather than reinforcing silos
Networking and resource-sharing can unite the movement and foster collaboration
Supporting innovative early career science communicators can accelerate the transition to science communication that is accessible by default
Funders can use their influence to hasten inclusive practices and encourage creative evaluation
Based on "The State of Inclusive Science Communication: A Landscape Study," produced by the University of Rhode Island's Metcalf Institute with generous support from The Kavli Foundation and Burroughs Wellcome Fund.
Graphic by Christine Liu

Table of Contents

The State of Inclusive Science Communication

How to Use This Report

This study aimed to provide a baseline understanding of the emerging inclusive science communication movement. We highlight common themes from the study related to definitions, challenges, novel insights from early career researchers and communicators, and pressure points that could stimulate or inhibit the field. The report concludes with recommendations for further exploration. Appendices include possible future research topics identified during the study, a commentary on terminology, and a glossary.

This study was small in size and, therefore, represents a snapshot of the current insights from early leaders in inclusive science communication. The ideas and insights of inclusive science communication are evolving in real-time, especially given the essential conversations about systemic anti-Black racism that have become more front-and-center in public discourse in 2020. Still, the report captures many ideas that can inspire deeper inquiry.

Finally, the report is intended for a wide range of audiences: students and professionals, researchers and practitioners (and the growing number of people who operate as researcher/practitioners), individuals and organizations. It does *not* aim to provide a list of "tips and tricks" or do's and don'ts for practicing inclusive science communication. Rather, the report summarizes a systematic investigation into the current perspectives of leaders who practice, study, and/or advocate for inclusive approaches to science communication. We expect the findings may generate as many questions as answers. This is a positive outcome, as the movement demands documentation, experimentation, synthesis, and critical reflection in this early stage.

Key Issue & Background

> ***"A lot of the things that I end up writing are about how we have to reimagine the space, because I don't think we have a good answer for what inclusive scicomm is. And part of that is because it's gonna be so context-dependent."***

Science, technology, engineering, mathematics, and medicine (STEMM) have the potential to empower or marginalize individuals and communities. Similarly, the ways we communicate about STEMM and engage people in conversations about science can enrich not only the research itself, but also public participation, sense of belonging in STEMM fields, and societal benefits from STEMM (Archer et al., 2015; Bell et al., 2009; Dawson, 2018, 2019; Dewsbury & Brame, 2019). However, our approaches also can perpetuate inequities (National Science Foundation, 2014; Schell et al., 2020). The COVID-19 pandemic has crystalized these challenges, demonstrating the urgency for science communication approaches that equitably serve and collaborate with audiences (Cordero & Davis, 2020; Dawson, 2020; Dawson & Streicher, 2020; Gollust et al., 2020; Jumreornvong et al., 2020, Michener et al., 2020).

As science communication[1] matures and expands, practitioners, trainers, and scholars must acknowledge the need to root their work in an ethic of inclusion and equity (see Canfield et al., 2020, for a detailed explanation of this rationale). Without an inclusive foundation, the relevant fields will be unable to achieve their objectives. The term "inclusive science communication" is used in this report to describe such a foundation and a broader movement that is building across related fields.

Specifically, we use the term "inclusive" in reference to science communication approaches that intentionally center diverse voices and identities, especially those that have been and/or remain marginalized in STEMM practice, research, training, and engagement, including but not limited to race, ethnicity, age, ability, gender identity, sexuality, and citizenship status. Inclusive science communication (ISC) is intersectional (Crenshaw, 1989), equitable (Polk & Diver, 2020; YESTEM Project, 2020), and, perhaps, a

---

[1] "Science communication" is interpreted here in the broadest sense, as any information exchange designed to engage specific audiences in conversations or activities related to STEMM topics.

way to build personal and community agency by providing varied "pathways" to engage with STEMM (Bevan et al., 2018).

In its many forms, ISC is a response to the calls from scholars, practitioners, and publics for a new approach to science communication that recognizes and appreciates diverse societal expertise (Yosso, 2005), builds a practice based in dialogue (Chilvers, 2012; Dilling & Lemos, 2011) and public participation (Dawson, 2018; Pearson et al., 2017; Trench, 2008), acknowledges the essential role of culture (Blue, 2019; Young Landis et al., 2020), and yields democratic access to science and science communication (Bäckstrand, 2003; Berditchevskaia et al., 2017).

While a growing number of science communicators are exploring and implementing inclusive approaches[2], there has not been a synthetic assessment of why or how the early adopters conduct their work, whether in research or practice settings.

Study Methods

Interviews were completed between July 2019 and July 2020. Given the relatively small pool of individuals who are centering inclusion and equity in their science communication work, we interviewed thirty leaders in this space to gain a broad sense of where the movement is and where it might be headed. The interviewees were carefully selected with input from an advisory group to represent a diverse suite of perspectives with regard to race and ethnicity, ability, career stage, discipline, experience, and methods. After initial interviews, additional interviewees were identified via participants' recommendations of fellow leaders. We primarily selected interviewees who work in the United States. This was a purposeful decision based on the study's small size and the significant cultural differences in science communication practice (Manzini, 2003; Canfield et al., 2020; Scheufele et al., 2009). Varied national and regional contexts related to historical and current inequities lead to different experiences of similar problems across cultures.

Interviews were supplemented with discussions and focus groups at several meetings and conferences where we shared initial study findings with conference participants to seek their responses and additional input. Participants were asked to comment on the degree to which these findings resonated with their own work and to

[2] For example, see recent special collections of the Journal of Science Communication in 2014 (https://bit.ly/2GxOqf1) and 2019 (https://bit.ly/3nypTa2) and Frontiers in Communication in 2020 (https://bit.ly/3mlpV4M).

share novel insights. The conversations included formal sessions at the 2019 Inclusive SciComm Symposium, 2019 Society for the Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS) annual conference and the 2020 Advancing Research Impact in Society (ARIS) Summit, as well as informal conversations following the 2019 Inclusive SciComm Symposium, at the Allied Media Conference, the ARIS Office Hours webinar series, and a National Sea Grant webinar.

The SACNAS discussion was specifically designed to engage early career STEMM researchers who are actively engaged in science communication activities. Twenty early career scientists were invited to participate based on their demonstrated ISC experience. We did not collect complete demographic information for these participants, but they were specifically selected to represent diverse perspectives by virtue of their sexuality, race, ethnicity, gender, disability status, and career stage, including identities not represented among other interviewees.

Detailed interviews with early- and mid-career ISC leaders were semi-structured, while conference discussions and focus groups began with a presentation followed by facilitated discussion. Interviews followed a script with additional questions as needed for clarification. Interviews were transcribed prior to qualitative analysis. The qualitative approach aimed to identify shared themes and experiences across interviewees, which are documented in this report.

Questions in the interviews and discussions were guided by our overarching research question: "How do researchers and practitioners view the opportunities and challenges related to inclusive science communication?" Transcripts from interviews were analyzed to identify participant motivations, areas of synergy among participants, gaps in current efforts, needs for future work, networks, and the pressure points that could stimulate or inhibit the broader ISC movement. The analysis also provides a rare reflexive look at the approaches these researchers and/or practitioners take in their work (see Chilvers, 2012).

Social network analysis was used as an additional tool to visualize and quantify the landscape of the ISC movement as identified by our interviewees. To build the social network map, interviewees were asked to name the key researchers and practitioners whom they viewed as ISC leaders. They also were asked to name people with whom they have collaborated on projects related to ISC, as well as anyone they turn to who is not yet particularly well-known in the movement. Based on responses to these questions, data were analyzed using the igraph package in R, an analytical and statistical software ecosystem, to visualize connections among leaders in the field and identify potential trends in relationships.

It is important to underscore that this study was a mainly qualitative exploration of the state of inclusive science communication among a subset of key leaders in this movement as identified with our advisory team and the interviewees. As reported below, many people do not see themselves as engaged in "science communication" at all, which points to the challenge of gaining a comprehensive picture. Thus, the findings provided here are intended to demonstrate overarching patterns and themes in this movement as identified by the interviewed individuals and focus group participants. There may be differing views that are not represented in this report. The results do not aim to generalize about all who are somehow connected to the ISC movement. Rather, the report summarizes the insights and concerns of a representative sample of individuals who are leading in their particular spheres of influence (Dawson, 2019).

Participant Demographics

Individuals interviewed for this study range in age from 26-60 years old, with an average age of 40 (Table 1). Individuals with PhDs are overrepresented in this sample. This, in part, reflects the career transitions many PhDs make from academic research to science communication. Demographic information of conference participants is not included in Table 1.

Table 1. Demographic information for study interviewees. Information in the "Other Important Identities" category was volunteered by interviewees when asked to name any additional identities of personal importance.

Demographic Category	Interviewees n=30
Average Age (years)	39.7
Gender Identity	
Cis female	24
Cis male	6
Race and Ethnicity	
Asian	4
Black or African American	6
Latinx	2
Multiple	6
White	12
Other Important Identities	
Disabled	4
LGBTQIA+	5
First-generation American	2

Demographic Category	Interviewees n=30
Highest Degree Completed	
PhD	18
PhD Candidate	3
Master's Degree	6
Bachelor's Degree	2
High School Equivalency	1
Employment Sector	
Academia	12
Science Museums and Centers	7
Nonprofit Science communication = 3 Science education = 3 Scientific society = 2	8
Journalism and Media	3
Region of Residence	
North America	23
Western Europe	7

Characterizing Inclusive Science Communication

Overwhelmingly, the consensus of interviewees was that, as currently practiced, science communication is not inherently inclusive. Some interviewees observed that the typical, accepted approaches of science communication center a Western, white[3], ableist, and patriarchal understanding of STEMM practice and who is involved with STEMM.

When asked to define "inclusive science communication," interviewees identified three key traits: intentionality, reciprocity, and reflexivity (Figure 1). Not all participants explicitly named all three of these characteristics, but they were implicit in nearly every interview. Importantly, the key traits must exist concurrently. While each trait is essential, any one of them alone is insufficient. All three traits are all linked by the common thread of equitable relationships.

While individuals with more extensive ISC experience were able to articulate more nuanced applications of ISC, all participants stated that true inclusivity requires committing to such an approach at the outset.

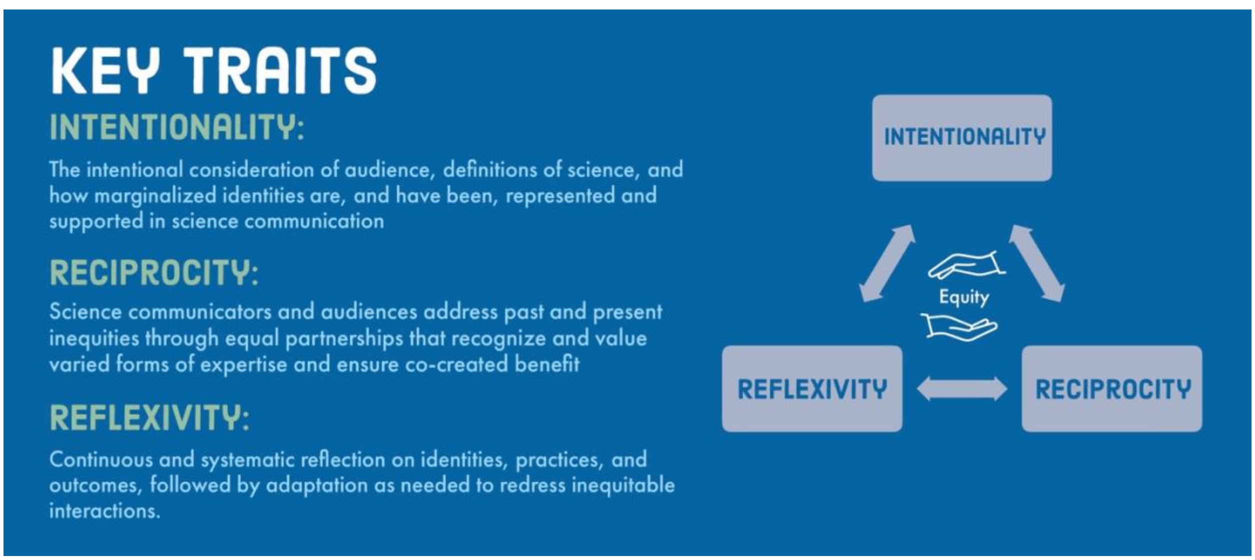

Figure 1. The key traits of inclusive science communication. Graphic by Christine Liu.

[3] We have intentionally used lowercase for "white" and capitalized other races in this document to counter white supremacy and the assumed centrality of whiteness in science communication and to acknowledge the intergenerational effects of race on lived experience (Daniszewski, 2020).

Intentionality

The concept of intentionality was the most consistent theme across all interviews. In planning and conducting ISC research and practice, participants emphasized **intentional consideration of the audience with whom one is communicating, how science is defined in one's work, and how marginalized identities are, and have been, represented and supported in engagement activities and communication products**. The importance of intention arose consistently when participants were asked to detail how ISC differs from typical science communication. From participants' perspectives, science communication activities typically do not include the three aforementioned considerations.

Audience consideration was the most common aspect of intentionality noted in interviews. Participants articulated the importance of intentionality not only in the most basic way of learning about the audience to best serve their interests, needs, and values, but in every aspect of one's interactions with a specific group. An intentional approach toward audience promotes collaboration and co-creation at all stages, from project design through implementation, evaluation, and, when relevant, dissemination.

In practice, intentionality is achieved by designing projects with audience or community goals in mind, not just the science communicator's definition of project goals (Beier et al., 2017; Pandya, 2014). Interviewees noted the necessity of learning about and acknowledging cultural histories and backgrounds of the audience that will be engaging with the activity or product. This self-education of the ISC practitioner and/or scholar includes recognizing and accounting for the intended audience's history of inequity or traumatic experiences with STEMM. Interviewees noted several examples of how intention can be practiced, such as:

- awareness of participants' lived experiences (Banks et al., 2007; Calabrese Barton & Tan, 2010; Hernández-Saca, Guttman Kahn, & Cannon, 2018),
- prioritizing cultural relevance (Augare et al., 2017; Garibay, 2011; Guerrero-Medina et al., 2013; Johnson et al., 2014; Johnson, 2019), and
- emphasizing a multi-directional, dialogue-based model of engagement (Beier et al., 2017; Garbarino, 2020; Safford et al., 2017).

Reciprocity

The second key trait of ISC, reciprocity, builds on the concept of intentionality. While interpretations of this concept varied by discipline and mode, they all generally reflected the need for "being with, rather than doing for" (Dostilio et al., 2012, p. 20) via **equitable relationships that recognize and value varied forms of expertise, apply asset-based approaches, and ensure co-created benefit for audiences and communicators/researchers/practitioners**.

There is a solid base of evidence to argue against the deficit model of communication (Trench, 2008; Simis et al., 2016); yet, dialogic and asset-based methods (wherein individuals' cultural knowledge and experiences are valued as assets rather than limitations, and their relationships provide social capital that can "fuel local associations and informal networks," per Mathie & Cunningham, 2003) are still not the norm—an inconsistency many interviewees lamented. In fact, this disparity is what drove many of the ISC leaders to conduct their own work differently: a desire to move beyond a model of unidirectional conversation to one based on equitable relationships and recognition of the varied expertise of people with different educational backgrounds and lived experiences. Reciprocity can manifest through efforts to build lasting relationships with intended audiences and/or collaborators who bring different expertise. For some, this is a move toward redefining what counts as "science" and who counts as a "scientist" (Cobern & Loving, 2001), and demonstrating how one's definition evolves to include and support ways of knowing and identities that have been historically excluded from STEMM (Bevan et al., 2018).

In science communication research and practice, reciprocity requires recognizing the different knowledges and experiences individuals bring to a conversation or collaboration. Reciprocity can be achieved through co-creation, iterative implementation of science communication research/practice, and by seeking and incorporating participant feedback into science engagement efforts.

For researchers, reciprocity involves working with relevant communities from the ideation phase of a project through analysis and dissemination, defining and revising the project with the relevant public audiences (Ramirez-Andreotta et al., 2015) or with practitioners, who often struggle with the gap between their own needs and the more theoretical focus of some researchers (Riedlinger et al., 2019; Salmon et al., 2017). One participant specified that reciprocity between research and practice also demands intentionally making all collaborators (scientists, practitioners, and community members) equal partners in the work.

Practitioners, too, must recognize the diverse assets and forms of expertise that audiences have when building relationships outside of research settings. Interviewees noted that reciprocity is achieved when participants are encouraged and supported to share their experiential knowledge while also learning from other participants' and the communicators' (informal educators', trainers', etc.) knowledges. The concept of "relational engagement" (Kearns, 2015) offers another way of considering reciprocity in practice settings, especially in the context of difficult issues (e.g., climate change) in which emotions complicate actions.

When applied with a focus on equity (as compared to the lower bar of mutual benefit), reciprocity also can promote a sense of belonging for individuals and communities who may feel marginalized from STEMM (Carlone & Johnson, 2007). For example, inclusively designed science exhibits and engagement activities might provide opportunities for participants to contribute to exhibit interpretation (Simon, 2010; Streicher et al., 2014), such as the Community Science Initiative of the Association of Science and Technology Centers and the Building Capacity for Co-Created Public Engagement with Science (CC-PES) project of the Museum of Science, Boston. Launched in 2019, the CC-PES "will facilitate conversations between community members and civic leaders on scientific topics of community interest. The project is designed to have a strategic impact on the way that informal science education institutions develop as conveners for their communities" (Museum of Science, 2019).

The field of service learning and community engagement (SL-CE) provides many useful insights on reciprocity to inform the ISC movement, including the literature on Asset-Based Community Development (e.g., Mathie & Cunningham, 2003), transformative reciprocity (Dostilio et al., 2012), and Democratically Engaged Assessment (Saltmarsh, Hartley, & Clayton, 2009). These concepts all call on those working in SL-CE to carefully consider their definitions and working applications of "reciprocity" to ensure they truly reflect co-creation and transformation.

Dostilio et al. (2012, p. 21) identify three "orientations" for reciprocity: "*exchange* (parties benefit), *influence* (parties impact the work), or *generativity* (together the parties produce systemic change, create new value, and/or undergo transformation in their way of being)." In other words, the key ISC trait of reciprocity is inseparable from reflexivity about how the communication/engagement is supporting collaboration to acknowledge power imbalances and remedy inequities.

Reflexivity

The third key trait of ISC is reflexivity, a **continuous, critical, and systematic reflection on the communicators' and audience's personal identities, practices, and outcomes, followed by adaptation as needed to redress inequitable interactions** (Clark et al., 2010). Interviewees noted that this aspect of inclusive practice often came to them as a moment of awakening. Some interviewees prioritized inclusive approaches from the start of their own work because of a desire to amplify representation of underrepresented identities in science. This was unanimously true for Black and multiracial female interviewees, who wanted to make science (and science communication) more inclusive for other women who are Black, Indigenous, or other people of color.

For others, however, there was a specific moment when they realized their work excluded certain identities and/or ways of knowing. Many, but not all, white female interviewees described such a moment of awakening during which they realized they had not been sufficiently, intentionally inclusive of identities different from their own. Further, some white women noted epiphanies about their relative privilege compared to the layered oppressions others experience (per Crenshaw's concept of intersectionality, 1989). Not specific to white women, multiple participants also pointed to science journalist Ed Yong's efforts to intentionally balance the gender representation of his sources (Yong, 2018) as helping them confront their implicit biases and exclusion of certain identities. Regardless of how or when they decided to prioritize inclusion, interviewees shared a more or less systematic approach of consistent self-reflection and personal assessment to consider if their practice is truly achieving their goals of providing meaningful representation of and engagement with those who have been marginalized in STEMM.

Humility, exemplified by a communicator's willingness to continue learning, was a common and defining characteristic of the individuals interviewed for this study, which may explain their tendency toward reflection. All study participants shared that they are constantly learning better practices for how to be more inclusive. Rather than feeling guilty about what they don't know, these leaders instead focus on gaining the knowledge and skills to redress the effects of exclusive or inequitable efforts.

Reflexivity can happen at the individual, programmatic, or institutional level, but most interviewees commented on this from an individual perspective. Individual reflexivity might lead one to reflect on their own assumptions, or on the ways that intersectional identities can complicate how a person's expertise is valued, and then determine that the most equitable and inclusive action is to step aside and let others take the lead. For example, one participant described wanting to share science with faith communities. Since she is not deeply religious herself, part of her reflection was the recognition that someone with a strong religious identity might be better equipped to do this work due to the importance of experiential knowledge and cultural understanding.

The STEM Ambassadors Program offers an excellent example of programmatic reflexivity that supports individual reflexivity. This public engagement training program, originated by Dr. Nalini Nadkarni, prepares scientists to engage underserved audiences by emphasizing scientists' and audiences' *shared* personal interests (Nadkarni et al., 2019). Importantly, the STEM Ambassadors model stresses the need for evaluation and reflection on engagement outcomes.

A participant gave another programmatic example of reflexivity in building a project team reflective of the audience they were trying to engage. As part of a science fair for autistic youth, the team included an autistic collaborator who informed the fair's design and structure. This approach recognized that a team of entirely neurotypical people could not achieve the same level of impact or benefit to the intended audience.

At the institutional or organizational level, reflexivity can refer to values (e.g., commitment to an equitable and anti-racist workplace) and practices (e.g., recruiting, hiring, and supporting staff of color to create a workplace that reflects stated values). For example, one participant noted an intentional hiring freeze of white cisgender women due to their overrepresentation on the team.

Institutional reflexivity also requires continued attention to broader societal goals. Bäckstrand (2003), for example, highlighted the role of institutional reflexivity in civic science, as a means for making Western science more accountable and responsive to various publics.

In any case, a common challenge is *how* to achieve institutional reflexivity. This challenge became especially apparent in 2020 in the context of the Black Lives Matter movement. Many organizations rushed to post a public Black Lives Matter statement in response to anti-Black racism and police violence. While these statements are important signs of solidarity, the institutional commitments are often less consistent (Batty, 2020; McKenzie, 2020). To address this discrepancy in STEMM fields, specifically, an "intersectional coalition of STEM professionals and academics" quickly coalesced to create the #ShutDownSTEM and #ShutDownAcademia initiative in June 2020 (shutdownstem.com). Their work to curate resources, amplify Black voices, and identify action plans was an excellent example of how individual reflexivity can scale up to the institutional level. Indeed, 2020 has offered many examples that can inform the ISC movement.

Challenges for the Movement

Interviewees were quick to name the challenges they have faced in their ISC work. The key barriers to the movement identified in this study were disciplinary, sectoral, and modal silos and a related missing sense of belonging; language barriers; limited knowledge and training; imbalanced representation; and the need for institutional infrastructure that can support systemic shifts and normalize inclusive, equitable practices (Figure 2).

Figure 2. Important challenges for the ISC movement. Graphic by Christine Liu.

Disciplinary, sectoral, and modal silos

Disciplinary, sectoral, and modal silos present a significant challenge to greater integration of inclusive and equitable practices (Lewenstein, 2011; Bevan & Smith, 2020). While very few participants explicitly called out these barriers, the sparse interconnectivity was revealed by the ways in which many interviewees self-associate within strict boundaries. The boundaries create redundancy, duplicate effort, and inhibit opportunities for collaboration (Bevan et al., 2018).

> ***"It's funny because we are so often reinventing the wheel. Because different disciplines don't talk to each other, we don't know the history of ideas or philosophies."***
>
> ***-Science communicator***

> ***"I'm a science educator, I'm not in the field of science communication. And I'm just sort of dabbling in the field now. And I think it's distinct from science education, but I also...feel like there's a lot of overlap. And it's hard right now. I'm having a hard time sort of parsing out what [is] science communication and what's science education and how [the] two fields overlap."***
>
> ***-Science education researcher***

Our interviews identified four major silos among ISC leaders. The silos are not neatly disciplinary; rather, they encompass diverse disciplines (theoretical underpinnings), sectors (structures and motivations), and modes (settings and methods). Specifically, the study found 1) informal science learning, 2) formal science education, 3) public communication or engagement by STEMM researchers (academics or other researchers who engage with public audiences about their research fields), and 4) science communication (encompassing all other modes) to be the distinctive separations among interviewees.

While many disciplines inform ISC, study participants frequently noted the need for researchers and practitioners interested in the movement to learn from scholars of critical race theory, and more broadly from the social sciences. Participants noted the importance of theoretical and practical understandings of the historical inequities of STEMM and society, and the need to recognize and apply the existing social science literature to ISC practice and scholarship.

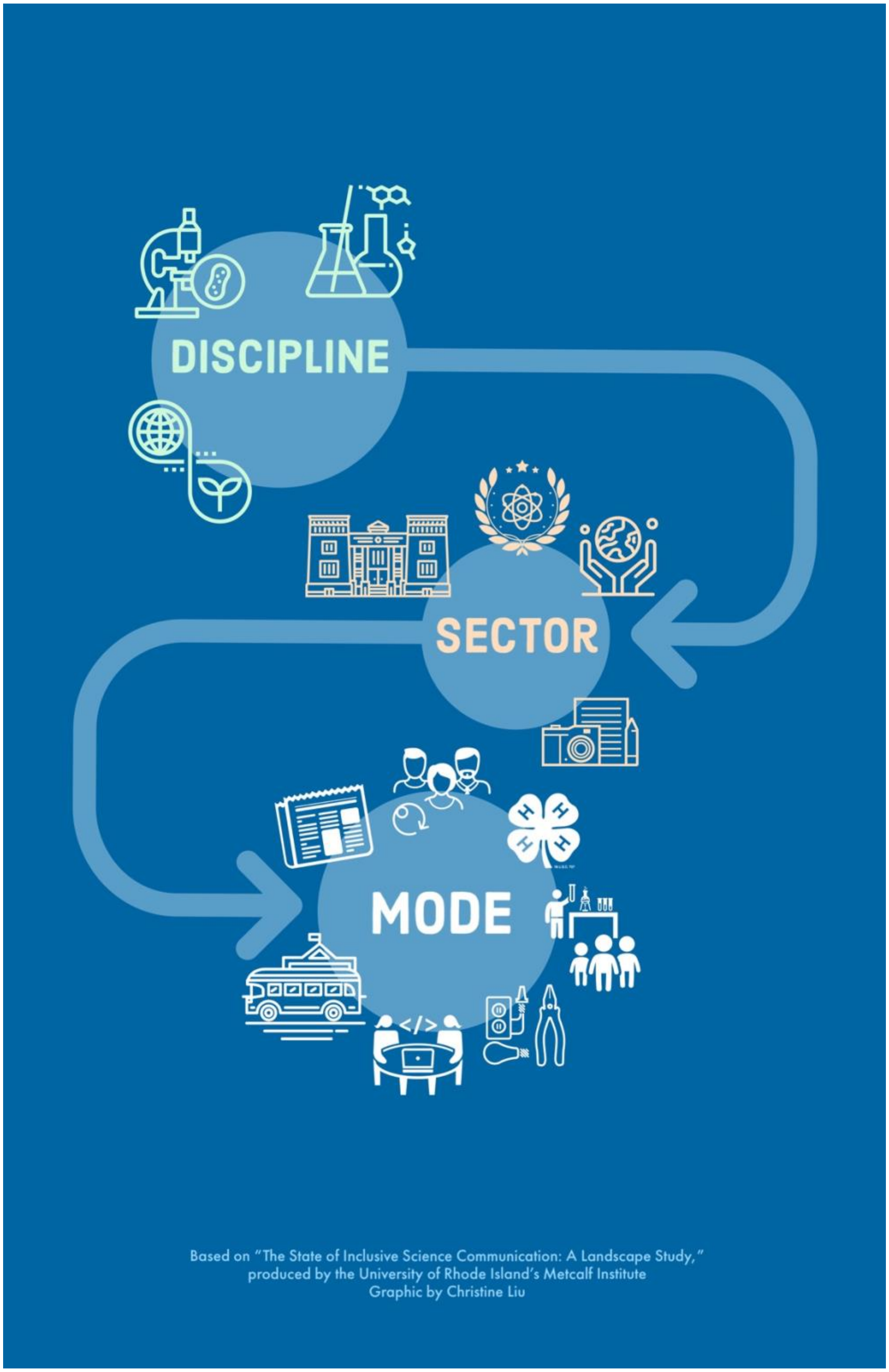

Figure 3. A communicator's disciplinary background may be applied across sectors and modes, producing myriad possible combinations of ISC practice and scholarship, and creating silos at various scales. Graphic by Christine Liu.

ISC also takes place across sectors, which include academia, nonprofits, government, and media. Science museums and centers, which are often non-profits, currently represent a distinct sector in ISC. ISC modes are very diverse, including social media, after-school programs, museum exhibits, podcasts, news articles, or maker spaces, among countless others (Figure 3).

When asked to name leaders in the field, interviewees' responses demonstrated the disciplinary, sectoral, and modal separations:

"I know [people] in the museum space, but not the science communication space."
-Science museum exhibit manager

"If you go into museums, it's a whole different group of people. If you stay with informal science learning, science communication, it's a whole different group again."
-Science communication researcher

Though the latter of these quotes comes from a participant who named leaders across many disciplines and modes, their framing reveals that these are viewed as distinct communities. Looking to practice and the literature, this challenge is demonstrated in the different terminology used to refer to the many ways organizations and individuals attempt to engage or communicate with public audiences about STEMM topics. This is one reason we chose to define "science communication" so broadly for this study: the term can fairly be applied to a wide range of activities and those practices, in turn, are informed by an even wider range of disciplines (Bevan & Smith, 2020). Relevant efforts include, but are not limited to: broader impacts (Moskal et al., 2007), citizen science (Bonney et al., 2015), civic engagement (Brulle, 2010), civic science (Clark & Illman, 2001; Bäckstrand, 2003), community engagement (Ahmed et al., 2017), community-based participatory research (Faridi et al., 2007), community *and* stakeholder engagement (Lavery, 2018), cooperative extension (Osmond et al, 2010; NIFA, 2020), informal science learning (Hofstein & Rosenfeld, 1996), public dialogue (Chilvers, 2013), public engagement (Stilgoe et al., 2014), science communication (Burns et al., 2003), science outreach (Laursen et al., 2007), and stakeholder engagement (Mathur et al., 2008). While these terms and approaches have important distinctions, they share significant overlap in goals and methods, at least in the context of advancing inclusive and equitable communication and engagement.

The overlapping goals and methods point toward the value of a "transdisciplinary" framework for ISC. ISC highlights the value of "creating ties between knowledge domains inside and outside of academia," "developing and adopting approaches that focus on joint problem framing and solution-oriented approaches" (von Wehrden et al., 2019, p. 876), and co-production, concepts that hue closely to the various interpretations of transdisciplinarity. Truly transdisciplinary, intersectoral, and intermodal conversations across ISC silos would accelerate inclusive practices, research, evaluation, and outcomes.

However, those individuals working in truly transdisciplinary ways may struggle to find a community of practice that suits their interests. Many ISC researchers and practitioners interviewed for this study shared a feeling that their dual focus on inclusion and science communication did not belong in any specific professional community.

"I only felt really included at this conference [the InclusiveSciComm Symposium]. I feel like I'm a veteran. Having been around a long time, I have a lot of experience, but there aren't necessarily venues where people want to hear me talk or welcome what I think."

Some study participants noted their feeling that the growing ISC movement represented the first space to provide a full sense of professional belonging. This was often the case for participants of color, who felt that ISC provides a framework for bringing one's full self to science communi-cation rather than expecting researchers to separate their scientist identity from their other identities. Others did not feel they belonged within the ISC community based on their science communication sectors or modes, as noted above in relation to science museums and terminology.

Social network analysis also highlighted the separation between ISC leaders (see the section on Mapping Inclusive Science Communication Networks). As one of the interviewees noted, silos are a classic problem among emerging fields (e.g., Chesbrough & Spohrer, 2006; Manlove et al., 2016). Science communication, in general, is underdeveloped and undertheorized, with a literature composing hundreds of case studies but few instances of synthesis across cases or theory development. These gaps are even greater within ISC.

Language barriers

> ***"Scicomm, I didn't even know that lingo before this conversation, so it's not a field that I consider myself versed in...so I don't know what the state of the field is now."***
>
> ***-Science museum leader***

Though intriguing, the goal of uniting disparate frameworks is hindered by a common—and very human—problem: we don't know what we don't know. Language poses the most significant challenge to transdisciplinary, intersectoral ISC practice. Researchers regularly conduct literature searches and, depending on the individual and their work, may be comfortable moving between disciplinary languages and methods. We especially observed this comfort with interdisciplinarity among the science education and science communication researchers interviewed for our study. However, those who work outside of a research setting, or who came to public engagement without a research background, may not find the literature as accessible, thereby limiting their opportunities to apply relevant research or practice.

In fact, the very language of this study posed a communication hurdle. Throughout the interviews, multiple participants, particularly those in the museum sector, noted that they did not identify as science communicators, despite being named by fellow interviewees or our advisory team as ISC leaders. This illustrates the degree to which language is a pressure point for the field: if individuals do not see their work as fitting within "inclusive science communication," they are unlikely to look for references or examples of relevant work in the science communication arena. Others based in the field of science education similarly felt distinct from science communication, as they are trained in the language, research approaches, and goals of science education rather than communication.

An additional language consideration for ISC, beyond the challenge of navigating the aforementioned silos, arises from the language used to communicate with public audiences. That is, engagement conducted in native languages and with attention to cultural considerations is far more inclusive. Therefore, while English is the dominant global language of Western scientific methods, it "often acts as a gatekeeper to scientific discourse," limiting access for non-native English speakers (Márquez & Porras, 2020; Young Landis et al., 2020) and artificially separating science from culture (Augare et al., 2017; Biyela, 2019).

Limited knowledge and training

The lack of pre-career learning opportunities and professional development to build ISC competencies is another major challenge, as indicated by the interviewee quoted to the right. This person was one of many study participants who identified a need for more formalized training that provides a holistic understanding of science communication writ large, from theoretical backing to implementation to evaluation of outcomes.

> ***"It is amazing that I have a reputation for communication, [but] I have, like, no training, and so, I don't know, necessarily, where my own gaps are in communication and how I can grow because I think the field of inclusive science communication is very new…I don't think that that is a good reflection of how we should be because I have no training. How can we improve ourselves as a field to serve people?"***

While there are a number of established and *ad hoc* science communication trainings available to STEMM researchers (Dudo, Besley, & Yuan, 2020), there was a sentiment among interviewees that many of these do not center the importance of inclusive approaches. More seasoned science communicators were able to identify an increasing nod to inclusion in trainings and at conferences in recent years, but study participants agreed that there are insufficient opportunities for people to learn how to practice inclusive public engagement with science.

Imbalanced representation in the movement

There may or may not be significant differences in willingness to conduct public engagement efforts by gender (Besley et al., 2018; Crettaz van Roten, 2011), but study interviewees shared a common sentiment that women are leading the charge regarding ISC. That imbalance among ISC leaders presents a challenge and potential pressure point for the field (Pérez-Bustos, 2019; Rasekoala, 2019). When creating the list of potential participants for this project, we had to make a concerted effort to identify more male and nonbinary individuals. Many female interviewees noted the disproportionate representation of women among those centering inclusion in their work. This observation holds when looking at the social network analysis, where 70% of individual leaders named by interviewees were female.

When discussing this issue, some interviewees noted their concern that the high proportion of women in ISC may lead to a devaluing of the work relative to bench science among academic peers. This fear was summed up by one person who wondered if the field would not be "valued as much until there are more men, like cis[gender], white, hetero-sexual, neurotypical, able-bodied men, that are doing this sort of outreach." Achieving more balanced representation among established and emerging ISC leaders demands constant effort and reflection at this early stage in the movement. Otherwise, in the words of one interviewee, ISC risks being "viewed as less than, that it's just the women crying about something or the minorities complaining about something."

The intersections of gender and race are also critical considerations in ISC (Previs, 2016; Rasekoala, 2019). Interviewees pointed to an overrepresentation of white women leading this work, which corresponds with some other studies of science communicators, more generally (AbiGhannam, 2016; Ecklund et al., 2012). Participants noted the need for greater diversity in science communication generally, including more disabled people and more people with marginalized gender, racial, and other identities. Amid broader concerns about how white women can perpetuate racial inequities (Boutte & Jackson, 2014; hooks, 1981) and the additional barriers women of color face in leadership roles (Sanchez-Hucles & Davis, 2010), this imbalance requires attention and action within the ISC movement.

Without diverse leadership, there is a risk of perpetuating the same inequities in representation that ISC aims to redress (Ishimaru & Galloway, 2014; Ray, 2019). This challenge relates to leadership positions (e.g., in projects, committees, and organizations) and to the available science communication training opportunities. A recent study of science communication trainers reported that 91% of the interviewees were white and 88% held graduate degrees (Dudo et al., 2020). Training programs rarely prioritize diversity in recruiting trainees (Besley et al., 2017) or emphasize "abilities to engage with diverse audiences" (Dudo et al., 2020). These gaps are especially notable with regard to science communication by and for the disabled or neurodiverse.

> ***"Science communication right now, especially more at the leadership level, tends to be dominated by white women. I would like to see that shift."***
>
> ***"I still think we face gender challenges in science communication. I worry that as with any other sector, that it could become, 'That's the thing that women do.'"***

Thus, as multiple interviewees noted, there is a need to intentionally recruit and support emerging leaders of diverse identities, abilities, and backgrounds to build the ISC movement. In the context of organizational hiring, interviewees were also quick to note that new hires or other types of leadership appointments need to happen only after an institution or organization has developed an inclusive, accessible, and anti-racist environment that actively supports people from marginalized communities. It is not productive, they noted, if an organization brings on people with underrepresented identities and then those individuals become tokenized and do not have the support of a culturally sensitive and inclusive work environment.

Lack of institutional infrastructure

The last major challenge for ISC noted by study participants can best be described as a lack of institutional infrastructure, especially across academic and nonprofit sectors. We use "institutional infrastructure" to refer to a range of issues that relate to an overall gap in the systemization of inclusive and equitable approaches at both the programmatic and institutional levels. This finding reinforces Bevan et al.'s (2018) identification of "systemic issues" as a key barrier in broadening participation in STEM. Landscape study participants identified four types of institutional infrastructure challenges.

Human Resources

Some interviewees noted the challenge of having one person or team that focuses on diversity, equity, and inclusion rather than making these the central, guiding principles of the organization. This approach, a common problem faced by those who are working on inclusion, diversity, equity, and access (IDEA)[4], treats inclusion as a side project rather than the driving force behind the organization's actions. Even when institutional leaders have prioritized IDEA in their workforce and practices, there may not be sufficient or consistent organizational buy-in to implement equitable or anti-racist hiring practices, for example. Study interviewees working at organizations that have prioritized inclusion shared that even when IDEA objectives are codified in writing, it can be difficult to secure broad

[4] There are many acronyms that address the goal of increasing representation, inclusion, equity, access, and social justice in STEMM and beyond. Alternatives to IDEA include diversity, equity, and inclusion (DEI); inclusion, diversity, equity, access, and leadership (IDEAL) (Science Museum of Minnesota, 2020); and justice, equity, diversity, and inclusion (JEDI). We chose to favor "IDEA" in this report because it specifically acknowledges the equal importance of accessibility, but we acknowledge that these various acronyms can create further silos.

agreement that the work is worthwhile or relevant to individuals' jobs. Absent multi-scaled, individual to institutional understanding of how IDEA is integral to the mission, and support of this integration throughout the organization's team, ISC is likely to be viewed as an "add-on" to the organization's work (Bevan et al., 2018). This view diminishes the intentions and outcomes of ISC and can exacerbate marginalization among team members and/or with intended audiences or collaborating communities. Conversely, when IDEA (and ISC) is conceived and practiced through a whole-institution lens, it yields a host of benefits related to participation, sense of belonging, collaboration, creativity, and outputs (Hurtado et al., 2017).

Financial Resources

Public engagement, by definition, requires interaction. Such interactive modes of science communication require longer time frames than one-way modes (e.g., journalism). ISC is even more time-intensive, relying on relationship-building within and between institutions, communities, and individuals (Bevan et al., 2018; Dawson, 2019; Humm & Schrögel, 2020). In the U.S.A., federal funding for inclusive science communication is often limited to a small "broader impacts" component of larger grants focused on STEMM research (with some exceptions such as the Advancing Informal Science Learning program at the National Science Foundation and the Community Engagement and Research Translation core of the NIEHS-funded Superfund Research Program). Private foundations have become an important source for public engagement funding, but the emphasis on quantifiable metrics and short-term outcomes among many foundations discourages the intentional, reciprocal, and reflexive practices of ISC that often require a slower project pace (Center for Evaluation Innovation, Institute for Foundation and Donor Learning, 2017).

Incentives & Reward Structures

While some interviewees found or created careers that explicitly value their ISC work, STEMM researchers consistently shared that their ISC efforts are more of a "side hustle," motivated by their personal passions but unrecognized by academia. This is a common challenge and has led to calls for a shift in how scientists are incentivized and rewarded for their science communication work (Anderegg, 2010; Dilling & Lemos, 2011; Schell et al., 2020; Scheufele, 2013). Researchers have noted the dual needs for clearly articulating the value of science communication within institutional settings and providing training in theory and methods to ensure that communicators are serving the needs of (and, we would add, valuing and co-creating with) the intended audiences (Bruine de Bruin & Bostrom, 2013; Dilling & Lemos, 2011; Fischoff, 2013; Scheufele, 2013). In short, a broad and explicit valuation of ISC across academic and non-academic spaces is essential to addressing the current gaps in institutional infrastructure.

Administrative/Leadership Support

Each of the aforementioned aspects of institutional infrastructure intersect with the organization's leadership. ISC leaders noted that administrators and funders push back on equitable approaches consistently, if not constantly.

Together, these institutional infrastructure challenges relate to an overarching concern among interviewees about the exhaustion they experience while attempting to overcome institutional or systemic barriers. This fatigue poses a significant challenge to the ISC movement. Even among these movement leaders, the effort of repeatedly having to justify the value of ISC to institutional leadership and peers, combined with the limited time available to develop equitable relationships and produce quality deliverables, leads them to sometimes opt for traditional science communication approaches that do not prioritize inclusion and equity.

Early Career Perspectives on Inclusive Science Communication

Insights gathered from early-career researchers and communicators (ECRC) at an invitation-only session at the 2019 Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS) conference revealed a distinct approach to ISC among these young leaders. Across the session's discussion groups, inclusion emerged as an inherent baseline for their engagement efforts.

ECRC also shared a tendency to reflect on how their science communication efforts can better serve the communities to which they belong. Many participants naturally gravitated toward inclusive, equitable approaches because they came into STEMM and academia from communities that have been underrepresented or excluded in those spaces. Some participants from immigrant families noted a feeling of responsibility to communicate their science to non-English speaking family members. Other participants wanted to build a bridge between the Western mode of scientific inquiry and other ways of knowing, or to provide more culturally-relevant examples of science that reflected their communities, or to better represent the experiences of disabled people in STEMM. Importantly, this focus on inclusion led some ECRC participants to a science communication practice that is more focused on advocacy for broadening sense of belonging in STEMM, especially for groups who have been poorly represented or historically excluded from STEMM, than on communicating scientific content.

Authenticity and creating community also were common motivations among ECRC study participants. Multiple participants noted their intentional choice to publicly embrace their own intersectional identities in their science communication work. Most often this manifested among ECRC participants in their approach toward social media: specifically, they chose to use a single Twitter account for both personal and scientific topics, in some cases reaching tens of thousands of followers. Embracing multiple identities is a perceived strength among ECRC communicators, as it serves to normalize that scientists are multifaceted people with hobbies and lives outside of the lab. As they bring their full, authentic selves to discussions about their experiences and personal activism, whether related to accessibility, navigating citizenship, visa challenges, racism, or homophobia, these early-career inclusive science communicators aim to help others feel welcomed in STEMM and science communication.

> ***"Being taken seriously is a barrier for me. There was...hesitance from people in doing outreach activities that are specifically geared for underrepresented minorities. I had to bombard people with research to convince them that I could do [even a small program]."***

The SACNAS participants mostly identified science communication as a "side hustle." In part, this may be a function of their primarily academic associations. In the case of early-career researchers, however, the side hustle is especially connected to power dynamics. Indeed, many of the ECRC participants noted their sense of professional limitation regarding ISC. Advisors and principal investigators often place constraints on when and how science communication is appropriate. Even when supervisors encourage the ECRC's science communication efforts, they typically advocate a deficit model of "talking at" people instead of engaging. Given the additional time requirements for truly inclusive engagement and academia's poor record of valuing "public and/or community engagement" in the promotion and tenure process (Alperin et al., 2018), it seems likely that few academic advisors, supervisors, or administrators would support this type of activity among their advisees or junior faculty.

Some of the SACNAS participants were content with viewing science communication as an extracurricular activity, but others wanted to make this their full-time career. In either case, the ECRC group identified several significant challenges that arise from the side-hustle vs. full-time career issue.

One concern relates to a sense of professional guilt. One participant described feeling conflicted about leaving bench science for science communication when her ISC work has specifically aimed to build a sense of belonging in STEMM for people with underrepresented identities. This notion that a person is "abandoning" science to pursue a professional career in science communication is a noteworthy psychological barrier (Alechine, 2019), especially among researchers who are themselves from marginalized communities.

A second concern is financial. ECRC expressed a common and consistent difficulty in finding funding and employment to do science communication, particularly full-time. In part, this problem was attributed to conflicting messages from funders and employers about how public engagement expertise is recognized. One participant explained that not having a degree specifically related to science communication leads funders to doubt her relevant expertise. For those explicitly trained within the field of science communication, the limitations they experienced were in finding jobs where hiring committees sought someone with a scientific degree to serve in communication roles rather than someone with a graduate degree in science communication. ECRC pointed to this as an example of the continued devaluing of the rigor of social sciences.

ECRC interviewees and SACNAS discussion participants, all of whom are building ISC platforms and/or careers, consistently expressed concern about the role of more senior scholars and practitioners in providing opportunities for their younger counterparts. Specifically, the ECRC participants desired proactive advocacy by more senior professionals to amplify the novel approaches and insights of more junior scholars and practitioners.

In ECRC interviewees' views, a major hurdle to practicing ISC within academia is the large amount of risk early career individuals incur in pursuing science communication work before securing permanent employment, or before achieving tenure. The transition to a broader, equity-focused public engagement workforce, they argue, requires that those with permanency and influence in the sphere use their power to reduce ECRC's risks of conducting ISC. Without this protection and support from more influential ISC practitioners and scholars, the new and important ideas of more junior colleagues may be ignored.

It is also noteworthy that the term "inclusive science communication" did not resonate with a number of the ECRC participants. This disconnect underscores the foundational appreciation or inherent assumptions of inclusion and equity that characterized the views of participants in the ECRC discussion. Several people noted that the "inclusive" modifier undermines the idea that all science communication should be inclusive. One person added that the word "inclusive" does not adequately convey the sense of "responsibility many of us feel we have when it comes to doing the work we do."

Mapping Inclusive Science Communication Networks

Social network analysis, or SNA, maps the connections between individuals to explain how a community of individuals interact with one another. We used an ego-network analysis (Kadushin, 2012; Kolaczyk & Csárdi, 2014), in which network development was established by asking each of the 30 interviewees, each of whom represented a focal point, or "ego," to name key researchers and practitioners in the field, past collaborators, and anyone else doing important work in this field who might not be well-known. Rather than being a complete social network, the analysis demonstrates the ego-network of ISC based on the thirty people interviewed for the study. This elicitation of the network presents a bias towards those whose memories easily recall names. While a limitation of the approach, this bias is helpful in documenting the connections that most quickly come to mind for each interviewee. This approach has been used previously to understand the intersection of informal STEMM education and science communication (Storksdieck et al., 2018).

This approach identified 252 actors (including people and organizations) as members of the ego-network of ISC leaders. SNA is a powerful tool: along with identifying the number of actors who are connected in a network, it also quantifies the strength of the network, based on the number of connections between individuals. The ISC network map shows a relatively sparse community, meaning that the 252 actors named by interviewees were not individually connected to many others (Figure 4).

The low overall connectivity of ISC leaders to one another is quantified by "graph strength." With a maximum value for graph strength of 1.0, the ISC network map has a strength of 0.07 (Figure 4). The limited strength of this network reveals that people are not talking to a wide variety of actors, which inhibits the transdisciplinary and collaborative possibilities of the ISC movement. In spite of this relatively sparse network of connections, it is noteworthy that only one set of connections is entirely disconnected (Group 14 in Figure 5). This shows that the interviewees do share connections, even if indirect and few. Again, this characterization is limited by the fact that the map is based on only thirty interviewees. In other words, not all people or organizations listed on the ISC network map had the opportunity to map out their own network of connections. However, the study reached a point where many participants were naming the same people, providing a check for thoroughness of data collection in this ego-network approach.

While most actors were individuals, 43 organizations or institutions were named in the analysis, representing 17% of all named actors. This reveals that, along with the individuals who stand out as leaders, there are also organizations that stand out to others as emphasizing inclusive approaches in science communication. While some of these organizations were named only by a single participant, others served the important role of providing a bridge or connection between multiple groups of actors (see the light blue circle in the middle of Figure 4).

Along with providing a visual representation of the ISC network, SNA can also quantify the various communities of actors in the network. Using the base map in Figure 4, communities can be further defined as a subset of actors that are "cohesive" (Figure 5). Cohesive communities are groups of actors that are both well-connected to one another and relatively separated from the rest of the network (Kolaczyk & Csárdi, 2014). A total of fourteen cohesive communities were identified, with three (community 14) to 47 (community 3) actors. Apropos of the limitation that not all network members named by interviewees were able to provide information on all of their connections, some of these "cohesive communities" are more accurately understood as personal networks (e.g., community 14 reflects solely the contacts of one interviewee).

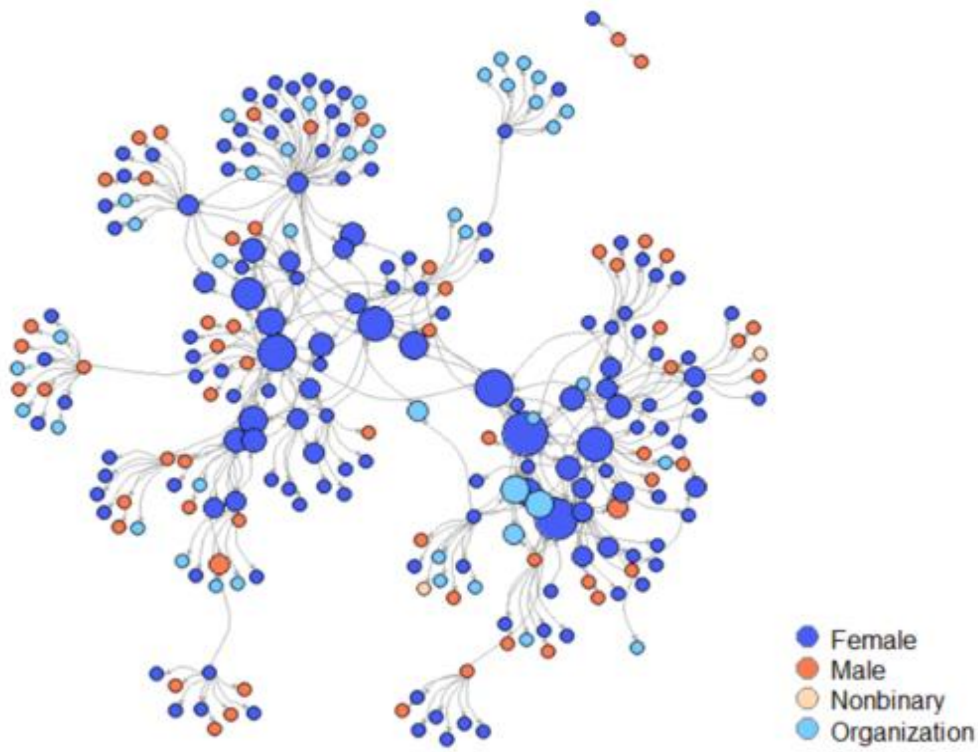

Figure 4. Network map of inclusive science communication leaders. Light blue circles reflect scientific organizations, societies, academic institutions or departments, and other institutions named as leaders in the field.

To provide more clarity on the different characteristics of people and organizations included in these communities, the shape of the node in Figure 5 reflects whether the individual or organization was identified as a practitioner, researcher, practitioner/researcher, or none of the above. Analysis of the communities revealed that there are no single-gender communities in the network, and that only two (communities 9 and 14) were made up of actors solely identifying as practitioners. Community 11 is notably monolithic, with just one practitioner/researcher within the otherwise entirely practitioner-occupied community.

This analysis and the comments of interviewees reveal a spectrum of ISC roles ranging from fully research-focused to fully practice-focused. The spectrum is likely, at least in part, a result of the study methodology, in which we asked interviewees to differentiate who they see as leaders in ISC research versus ISC practice. Still, the overlap between researchers and practitioners in these communities reveals that the roles of "researchers" and "practitioners" in the ISC landscape are less distinct (that is, less siloed) than it may seem when looking solely at the connections of a single interviewee. These blurred lines between researcher and practitioner are encouraging; perhaps this provides another way to think about building stronger networks within the movement and integrating research and practice (Riedlinger et al., 2019; Ginexi et al., 2017). Further, contrary to the findings of Storksdieck et al. (2018) in mapping the intersection of science communication and informal STEM education, we found that interviewees were able to name people they viewed as ISC practitioners more easily than those they viewed as researchers.

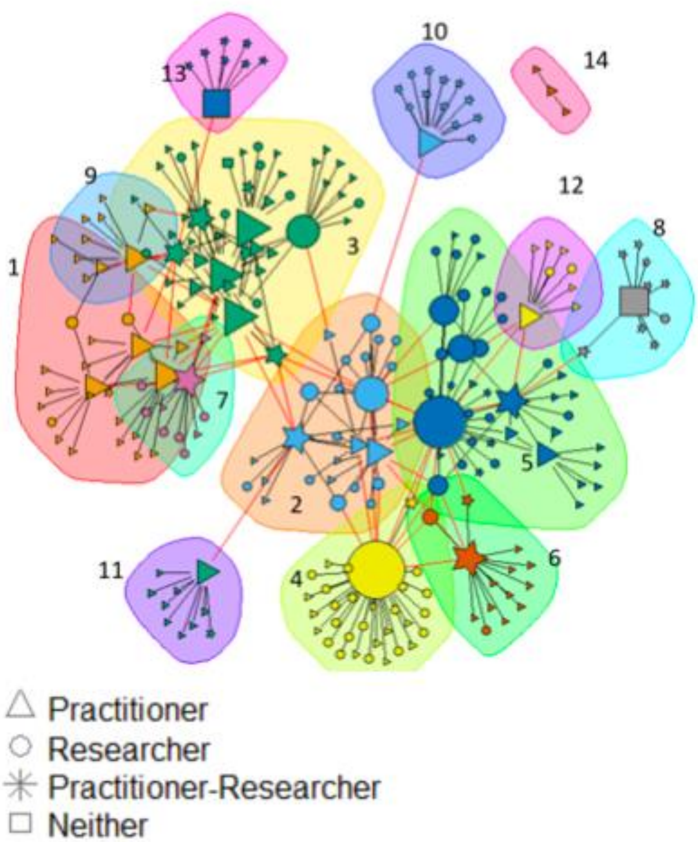

Figure 5. Cohesive communities within the network of inclusive science communication leaders. The shape of each node reflects whether the individual or organization was identified as a practitioner (triangle), researcher (circle), somewhere in between (star), or none of the above (square). Red lines connecting two shapes denote actors that are connected in the network but were identified as distinct communities in the clustering analysis.

Pressure Points to Stimulate or Inhibit Inclusive Science Communication

With any new movement, specific actions can have outsized effects to advance or constrain its development. This study identified four key pressure points for ISC.

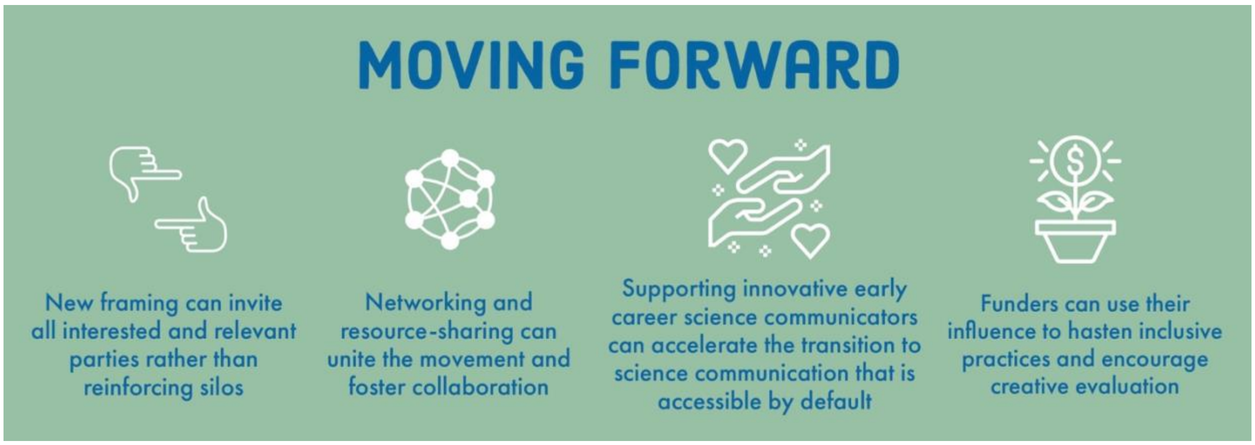

Figure 6. Key recommendations for advancing the ISC movement. Graphic by Christine Liu.

Framing of the movement

Inclusive science communication is an evolving response to specific limitations of science communication as it is typically conceived, studied, and practiced. Ironically, as noted by some study participants, the term can have exactly the opposite effect of its intention by making some relevant parties feel excluded. A critical step, then, is to develop new ways of framing this work that invite all interested and relevant parties, rather than reinforcing silos.

Beyond the specific language of the movement, we must consider its broader goals. When asked what the future of ISC could look like, participants identified the idea of a “radical rebranding” of science communication. As with the need for greater institutional infrastructure described above, a radical rebranding would center IDEA in all science communication moving forward. This call has roots in diverse settings that could provide templates and learning for the growing ISC community. Anila (2017), for example, argued for the need to “fracture” art museums’ interpretive planning processes to center inclusion in curatorial practice, exhibit design, and patron engagement. That interviewees from a variety of disciplines and sectors independently used the language of “radical” change in their descriptions demonstrates a synergistic possibility--and enthusiasm--for overhauling the traditional paradigm.

A remaining challenge, then, is how to approach this radical rebranding in a way that allows those from disparate but related fields to see themselves as part of the bigger picture.

Opportunities for collaboration and building community

This study highlights the opportunities for transdisciplinary, intersectoral, intermodal collaboration and the need to connect siloed networks. While the language used in different sectors and disciplines varies, interviewees in this study shared the primary goal of creating more equitable and inclusive ways to build science capital and public engagement with STEMM. The history of “science communication” in the U.S. helps to explain the silos observed in this study and others (Bevan & Smith, 2020) as well as the challenges in identifying a path for shared learning. It seems possible that the ISC movement could be a motivational umbrella under which individuals and organizations could collaborate to address shared goals by combining the diverse methods and competencies from these distinct perspectives. A twist on Lavery’s (2018) suggested customer-relations management and human-centered design framework for community and stakeholder engagement could further clarify a path for shared learning by clarifying the objectives of the ISC movement in ways that would bypass the silos. For example, ISC practitioners could build an ethical foundation for science communication by centering the interests, insights, and perspectives of marginalized communities; “critically examining and refining the design of [science communication] in response to the specific circumstances of a given...setting” (p. 555); and creating “highly transferable models” (p. 555).

New alliances and convenings, both in-person and virtual, can embody the traits of ISC, support network building, spark new ideas, and expand participants’ understandings of the diverse approaches to ISC (Canfield et al., 2020; Smith et al., 2020). A number of existing conferences can support this type of exchange, including Reclaiming STEM, the SciAccess Conference, the InclusiveSciComm Symposium hosted by the University of Rhode Island’s Metcalf Institute, the Science Talk conference, the Science Events Summit, Rockefeller University’s SciOut conference, the Advancing Research Impact in Society

(ARIS) Summit, the Association of Science Technology Center's annual conference, the European Network Science Centres and Museums (Ecsite) conference, Allied Media Conference, Public Communication of Science and Technology (PCST) and others. Other regular convenings, such as the National Academies of Science, Engineering and Medicine's Sackler Colloquium on the Science of Science Communication and the annual conferences of the National Association of Science Writers, Society of Environmental Journalists, and numerous scientific societies (Hendricks, 2020), could be powerful partners in the effort to forge new alliances while helping their traditional attendees recognize new ways to approach their work.

Yet, meetings, alone, cannot provide the ongoing community building that the movement requires at this point. There is a need for continued dialogue about and practice of engaging with issues of power, privilege, and race (Miller et al., 2004) that extends past the length of a meeting.

Throughout the study interviews, when asked to name key leaders in the field, participants often listed Twitter handles rather than the actual names of ISC practitioners. Social media has been key to launching many inclusive science communicators' practice as well as their sense of community. Twitter, specifically, has served as an integral platform for the emergence of an ISC community online.[5]

Particularly for early career researchers and science communicators, Twitter provides a space where they can share their views and knowledge, build communication skills, form identities (Reed, 2013), and explore their own boundaries for authentic engagement. While this is an important venue for sharing and, to some degree, learning, it is limited in scope and audience. Sustained transdisciplinary movement building will require engagement with relevant networks and communities well beyond Twitter and other social media platforms. The identification of new spaces and places for community building will help to stimulate the field.

The 2020 coronavirus pandemic illustrated, quickly, the potential of virtual convenings for meeting some of this need. Online activities such as the Ecsite webinar series and monthly SciEngage Virtual Meeting hosted by the American Association for the Advancement of Science and the National Academy of Sciences are intended to share

[5] That ISC Twitter community, itself, has been largely influenced by individuals who had been actively engaged in Science Online (Lee, 2014), a conference and community that emerged in 2007 to convene people who were blogging and doing Internet-based public engagement (Russell, 2011).

resources and build connections. "Community listening sessions," such as those produced by Daniel Aguirre in collaboration with the Science Festival Alliance and Science Events Summit, can serve as opportunities for learning, public engagement *and* community building among ISC networks.

While virtual meetings and gatherings can offer greater accessibility in some regards, there are important caveats. Organizers must ensure that disabled attendees can fully participate by providing live captioning, sign language interpretation, alt-text or other accommodations as needed (IFES, 2020). Virtual interactions are prefaced on participants having reliable internet access, which is not necessarily a safe assumption. Also, virtual meetings require careful planning to foster engaging discussions, beginning with intentionality about the meeting's objectives (Center for Scientific Collaboration and Community Engagement, 2020).

Leadership of early career researchers and communicators

For some study participants, especially those in earlier career stages, pursuing inclusive science communication can feel like trying to climb a mountain of loose sand. That is, their commitment and enthusiasm for practicing ISC are constantly tempered by lack of training, institutional hurdles, unsupportive administrators, supervisors, or mentors, and financial insecurity. More explicit institutional support structures could ameliorate this challenge.

One more senior leader called out this reality, saying, "we don't design systems and people to achieve what we're looking for." Rather than creating space to foster the development of ECRC's assets, deficit approaches are the default and norm among many scientists and science communicators. Early career researchers and communicators are often expected to follow the pathways of their advisors and more senior professionals rather than being given space to amplify and share their own ideas. Given the inherent focus on equity and inclusion observed among ECRC in this study, it is reasonable to hypothesize that their growing participation will naturally lead toward a model of science communication that is inclusive by default. This transition, however, requires that those with power and influence in relevant fields hold doors open for the next generation of science communicators and support those younger voices as they lead with different perspectives and novel, potentially risky approaches. Indeed, efforts to support and include junior scholars, combined with a willingness to engage with diverse disciplines, have been found to be important contributors to early career scientists' research and personal success (Nielsen-McPincus et al., 2007; Roy et al., 2013). Research efforts to examine and quantify the value of ISC leadership by junior scholars and practitioners could provide the evidence needed to gain greater institutional support for their work, while validating ISC's contributions to ECRC's professional development and impacts.

In response to gaps in opportunities and representation, early career researchers and communicators are already contributing important innovations in the science communication sphere. Again, Twitter represents an influential platform in this regard. Stephani Page was an early leader with her development of the hashtag #BLACKandSTEM, launched in 2014 during her work as a biochemistry doctoral student. The hashtag, which Page created to connect Black students and professionals in STEM fields, proved to be a simple, powerful tool for building community (Zax, 2014). The approach continues to work. More recently, #BlackBirdersWeek, a social media campaign launched in May 2020, sparked a global response by highlighting Black birders and Black scientists and raising awareness about the harassment and threats that Black people often experience in the outdoors (Langin, 2020; Mock, 2020). This campaign and its organizing group, The BlackAFinSTEM Collective, achieved a massive impact and inspired nearly 20 week-long Twitter campaigns in 2020 dedicated to highlighting Black researchers in various fields, covering topics from botany to mental health to, of course, science communication (Figure 7).

The leadership of early career communicators is expanding the frontiers of ISC in meaningful ways beyond Twitter, too. Examples such as Guerilla Science, co-founded by two ECRC in 2008 to engage "latently interested publics" in STEMM through interactive experiences (Rosin et al., in press); the translation of ecological data into music to engage visually impaired people in the interpretation of complex scientific narratives (Sawe, Chafe & Treviño, 2020); Reclaiming STEM, a science communication and policy workshop organized by and for marginalized ECRC; a science comedy show addressing the racism and harassment Asian Americans faced as the coronavirus pandemic began (Association Chat, 2020); the creation of new visual representations of scientific terms to expand the American Sign Language vocabulary (Poor, 2018); and explanations of microbial ecology through Indigenous Hawaiian culture and dance (Frank, 2017) show that these early career ISC leaders have much to offer to the broader science communication field. Although social media have provided an invaluable space for authentic interactions without gatekeeping, it is important to ensure that ECRC have opportunities to share their insights in other spaces, too. Creating leadership opportunities for these younger ISC leaders within more traditional institutional settings will inform and sustain the movement.

Figure 7. The BlackAFinSTEM Collective issued a continued call to action following #BlackBirdersWeek. Graphic by BlackAFinSTEM for Instagram. Used with permission.

Of course, these young leaders must be able to secure compensation, gainful employment, and funding for their projects. Funders, whether federal granting agencies or private foundations, can play a critical role in validating this work and, therefore, advancing it. For example, agency funders could: require, or at least emphasize, ISC practices in their proposal guidelines; encourage project leaders to include modest financial compensation for participating students and community members; and encourage participation of graduate students or postdoctoral scholars in science communication projects.

Evaluation and funding

Finally, our interviews underscore the idea that evaluation of ISC approaches is lacking. Only four interviewees (two in academia and two in science communication nonprofits) brought up the importance of evaluating whether ISC is actually achieving its intended IDEA and communication goals.

The lack of evaluative data across informal science learning and science communication is not a new concern (Patrizi & McMullan, 1998; Salmon & Roop, 2019; Storksdieck et al., 2018). Nonetheless, it presents a significant barrier to the development of the ISC movement specifically, and a ripe opportunity for growth. In their analysis of similarities and differences between informal science education and science communication professionals, Storksdieck et al. (2018, p. 13) found that people in both communities tend to rely on their own customized, ad-hoc assessments rather than using existing measures that assess "constructs common to both fields (such as science interest, science identity, and science engagement)." This gap further demonstrates the need for cross-fertilization among disciplines, sectors, and modes.

Many interviewees were interested in knowing what the ISC best practices are, but these cannot be known without evidence gained from evaluation and research (Jensen & Gerber, 2020). Thus, a greater focus on independent evaluation of ISC practices is needed to build adaptable **"promising practices."** An interviewee introduced this term to deliberately acknowledge that these practices should not be considered static, perfect approaches. Rather, a promising practice is one that has been tested and found to be successful in some contexts. This language reflects the key traits of intentionality and reflexivity by framing ISC practice as context-dependent and adaptive: certain practices may work best in specific scenarios and may be helpful in informing which practices are best in other contexts.

Participants also noted a very specific limitation in evaluation to date: funding timelines. Often, projects are funded for a period that only allows for execution, without sufficient time or money for evaluation. Indeed, because of the longer timeframes required for building equitable relationships, ISC practitioners and scholars may be actively disincentivized to include evaluation, as the additional expense could further hamper their ability to execute a project. Extending funding timelines and budgets to include thorough, independent evaluation would emphasize the importance of evaluation and advance the field based on evidence.

Recommendations for Advancing the Movement

In many ways, 2020 could mark a watershed moment for inclusive science communication, as the combination of COVID-19 and broader public recognition of systemic racism and other inequities have led to a greater sense of urgency about inclusion, equity, and intersectionality as it relates to STEMM in our daily lives. Although the ISC movement is rapidly evolving, we offer some recommendations that are essential key steps at this juncture.

1. Embed the key traits of ISC in all science communication practice

We urge individuals, programs, organizations, and institutions to embrace a goal of making their public engagement with science "accessible by default," as one interviewee described it. Based on the insights of early leaders in the field, intentionality, reciprocity, and reflexivity—practiced in tandem—are the hallmarks of ISC and offer a starting point for the movement. Furthermore, these traits offer a foundation for experimentation and evaluation that could inform global efforts to define and expand effective science communication.

Interviewees explained that the transition to this new paradigm for science communication will require time and funding. Importantly, this shift, and the institutional infrastructure needed to catalyze and support it, cannot be portrayed as a one-size-fits-all approach for science communication. Rather, **each program, institution, or organization must build iteratively on the key traits of inclusive science communication, adapting as needed to suit their specific situation.** Establishing a process for considering and adaptively implementing the key traits will allow teams to identify strengths and weaknesses in their activities and approaches. Whether practitioner, researcher, or both, ISC advocates can embed these traits in multiple ways, including the following examples from study interviewees.

a. Practice humility and embrace difficult conversations.
b. Require and support meaningful participation of diverse and, especially, marginalized identities in public engagement efforts.

c. Showcase the range of people who engage in STEMM to help individuals build science identities (e.g., by creating identity-based organizations to promote and support access to STEMM or advocating for broader definitions of science to acknowledge multiple ways of knowing).
d. Ensure that communication/engagement efforts are culturally relevant and physically accessible.
e. Seek and document the stories of individuals who have been intentionally and/or historically excluded from STEMM spaces as a means of demonstrating the difference between inclusive and exclusive approaches.
f. Co-create research projects with communities, where community leaders are equal partners throughout the course of the study.
g. Develop theoretical and conceptual frameworks to describe the implications of current exclusive educational and social systems.
h. Create action plans to move from individual and team commitments to systemic (institutional and organizational) adoption of inclusive practices.

2. Embrace transdisciplinarity and intersectoral, intermodal expertise

Integrating diverse disciplinary, and even anti-disciplinary (e.g., Cooper et al., 2018), perspectives is essential to advancing ISC and improving the movement's collective impacts. But transdisciplinarity can be a double-edged sword, both helpful in terms of uniting frameworks and avoiding duplication of effort, and a hindrance in terms of the lack of shared foundational knowledge and terminology needed to move between the different worlds. Some approaches for dismantling these silos are listed below.

a. **Read literature and experiment with engagement and communication approaches that are outside of the norm for one's field.** The following knowledge domains provide helpful examples.
    i. Equity-focused education: Researchers have incorporated critical race theory (Ladson-Billings, 1998; Delgado Bernal, 2002), critical disability theory (Goodley, Liddiard, & Runswick-Cole, 2018; Meekosha, 2011), queer theory (Gunckel, 2009), asset-based pedagogy (Lopez et al., 2017), Indigenous ways of knowing (Medin & Bang, 2014; Lemus et al., 2014; Glasson et al., 2010; Johnson et al., 2014), rightful presence (Tan & Calabrese, 2020), and many other relevant approaches to make education more inclusive and equitable by "carefully examin[ing] and address[ing] the cultural and political contexts

and consequences of our scholarship" (Phillip, Bang, & Jackson, 2018). Even when initially applied in formal learning settings, much of this work is readily applicable to informal settings and other public engagement applications (Lemus et al., 2014; Orthia, 2020).

ii. Indigenous knowledges: Indigenous knowledges and epistemologies offer valuable insights for ISC in many regards, not least in highlighting diverse definitions of science and the ways that knowledge, relationships, and intergenerational communication can be intertwined (Bang, Marin & Medin, 2018; Whyte, 2017). When seeking to collaborate with Indigenous communities, science communicators should explore related issues of Indigenous knowledge sovereignty and self-determination (Latulippe & Klenk, 2020; Orthia, 2020), community ethics, (Clark et al., 2010) and decolonial methods (Smith, 1999). Examples of engagement efforts that center Indigenous ways of knowing can be found across informal science learning (Augare et al., 2015; Mack et al., 2012), science education (Johnson et al., 2014), and public health settings (Hunt, 2015), among others. The ancient, Indigenous histories of "science communication" outside of the Western model warrant much more exploration for ISC (Orthia, 2020, p. 2): "[i]nsofar as access to science communication facilitates social power, a desire to radically democratize ownership over it may be served by conceptualizing its history as bigger than the West and older than recent centuries... Since this research field is still in relative infancy, it is timely to intervene now."

iii. Service learning and community engagement: This wide-ranging field offers many concepts relevant for ISC, such as Asset-based Community Development (e.g., Kretzmann & McKnight, 1993; Mathie & Cunningham, 2003), transformative reciprocity (Dostilio et al., 2012), and Democratically Engaged Assessment (Bandy et al., 2018). Asset-based Community Development is both a strategy and a set of methods developed in response to the destructive effects of viewing communities through a needs-based (or deficient) lens. Such a deficiency mindset can lead to a perverse reinforcement of extractive power structures rather than a supportive, equitable engagement.

iv. Community organizing: Some argue that community organizing techniques can address a gap in some service-learning approaches, namely, the power imbalances at the interface of higher education and community knowledge (Josephson, 2018). The Leadership Academy for Social Change, a program of The Global Action Research Center, explicitly links community organizing and science communication with a focus on educating and activating community members. The Root Cause Research Center offers another example for ISC. They work with community members and train them in research, community organizing, and design to help community members tell their own stories and launch research projects to address important community issues. This combination of community-centered science communication, participatory research, organizing and design is based in the concept of "movement science," a "spectrum of practices in which practitioners employ a wide variety of communal, cultural, political, artistic, and technical skillsets in order to gain traction against convoluted systems of oppression" (Root Cause Research Center, 2020).

v. Art and Design: There is ample evidence demonstrating how art and design can improve the practice, teaching, and learning of STEMM when viewed as integrated components rather than add-ons (Jacobson, Seavey, & Mueller, 2016; Rodríguez Estrada & Davis, 2015). Relevant examples for ISC come from maker spaces (Richard & Giri, 2017; Yi & Baumann, 2018), gaming (Richard, 2013), photography (Frazier, 2016), zines (Two Photon Art, 2017), and poetry (Buolamwini, 2018), among countless other modes. Allied Media Projects, which aims to "cultivate media for liberation," provides another model for the trans- and antidisciplinary collaborations that could advance the ISC movement. Through their programs and an annual conference, Allied Media Projects facilitates "media-based organizing," which they define as a "collaborative process of using media, art, and technology to advance a more just and creative world" (Allied Media Project, 2020).

b. **Establish equitable collaborations among people and organizations along the entire practice-to-research spectrum.** Recognize that the silos separating relevant fields nearly always leave practitioners out of the discussion (Suldovsky, McGreavy & Lindenfeld, 2018).

c. **Build appreciation for transdisciplinary thinking by embedding diverse disciplines, sectors, and modes in science communication courses and trainings.**

3. Critically analyze language of practice & research to reflect ISC key traits and break down silos

While incorporating learning from disparate disciplines it is also important to emphasize language and framing that brings diverse approaches together, rather than reinforcing or perpetuating silos. The jargon used within each silo (e.g., outreach, science efficacy, stakeholder, broader impacts) may seem straightforward to that silo's inhabitants, but this language has the power to exclude potentially interested partners and collaborators. Our results mirror previous studies showing that disciplinary language can be a particularly challenging issue for practitioners who tend to prefer research syntheses and reports over primary literature (Storksdieck, et al., 2018).

Language can also signal values. For example, von Wehrden et al. (2019) argued for the use of "knowledge domains" instead of "discipline" to recognize knowledge that originates outside of an academic framework.

In working to achieve a more inclusive practice, we urge collaborations across silos to carefully consider language choices and co-create definitions that reflect the key traits of ISC and foster transdisciplinary, intermodal exchange and understanding. This process could create a positive feedback, resulting in new, creative collaborations as more people recognize the overlap and synergies that exist across disciplines.

The very language of this movement could shift, and perhaps should, to increase sense of belonging across the silos. At this point, "inclusive science communication" can at least serve as a placeholder to build a shared sense of purpose.

4. Expand opportunities for multilingual engagement

ISC can remedy the shortage of culturally and linguistically accessible science communication, a shortcoming that motivated one of our interviewees to begin her ISC career. Márquez & Porras (2020) suggested several remedies for the gatekeeping effects of English-only science communication, including providing culturally relevant context in science communication efforts, implementing multicultural science communication training, encouraging scientists to communicate in their native languages, and creating online communities where science communicators can interact via languages other than English.

Situations when languages do not contain equivalent words for scientific terms can be viewed as opportunities to practice ISC and to explore power, privilege, and decolonial methods. The Learning Center for the Deaf, for example, provides training and resources to support "culturally and linguistically accessible education for deaf and hard of hearing students." Their ASL Clear program is designed to "increase the sharing of contextualized STEM terms in American Sign Language" (Learning Center for the Deaf, 2020). South African journalist Sibusiso Biyela described his efforts to decolonize science writing by writing about science in Zulu, his native language (Biyela, 2019). This motivation transformed his writing from "just a news piece" to an effort "to right a societal wrong" by making scientific discussions accessible. Biyela noted that he went beyond simple translation to conceiving the writing entirely in Zulu, which required a combination of "invent[ing] some terms, augmenting others, and...provid[ing] explanations." Another important aspect of Biyela's approach was to incorporate storytelling, a culturally relevant method for science communication that can be essential for building personal agency (McCarty et al., 2018).

5. Create and sustain in-person and virtual networks and resources to build community

This study clearly demonstrates the need to build community among science communicators to advance inclusive practices. While annual or biennial conferences are helpful in this regard, the growing ISC community needs more frequent and accessible opportunities for learning, networking, and collaborating, such as the following approaches.

a. **Create transdisciplinary, intersectoral, and intermodal communities based on shared expertise or interests.** Within science communication spaces, there are many smaller communities built around communicators' cultural, educational, and/or professional backgrounds. The SciComm Trainers Network, launched in 2019, offers an example; the network brings together science communication trainers to cultivate community, professionalize the field, and broaden participation (SciComm Trainers Network, 2020). Other potential communities might be STEMM researchers who incorporate science communication into their work or ISC practitioners who focus on particular issues (e.g., public health, environmental justice, gene editing, space exploration) across modes. These communities of practice could be especially valuable for those individuals who are not full-time science communicators.

b. **Develop shared resources and disseminate widely.** Participants expressed the desire for a centralized repository of relevant literature across disciplines to facilitate the learning that comes from exploring new bodies of literature and resources. There has been a burst of resource sharing related to anti-racism in response to more widespread public discussions of systemic racism following the murder of George Floyd in 2020. These efforts could serve as a model for the ISC movement. As of late 2020, several platforms exist or are under development that could help to break down ISC silos: the Center for Advancement of Informal Science Education (CAISE) website and their Broadening Perspectives on Broadening Participation in STEM Toolkit, Allied Media Projects' resources, the Advancing Research Impact in Society (ARIS) Community portal, Rockefeller University's RockEDU Inclusive Science Outreach resources, a crowdsourced Inclusive SciComm Symposium Resource List, the Association of Science and Technology Centers' Communities of Practice, and a new database of science communication resources under development by the Alan Alda Center for Communicating Science.

c. **Encourage ISC networking and collaboration via scientific societies and other associations.** This was largely undiscussed among study participants, even among early career scientists who participated in the context of a scientific society meeting. Particularly for individuals looking for jobs, scientific societies can provide valuable opportunities for networking and possible research and/or communication collaborations. This suggestion presents an opportunity for more intentional growth of the ISC community within and across scientific societies (Hendricks, 2020), especially those already seen as leaders in ISC research or practice.

d. **Leverage highly interconnected organizations to create bridges between individual leaders.** Per the findings of our social network analysis, bridge organizations could create a more connected network among actors with shared interests in the ISC movement. While interviewees were not prompted to name organizations in this study, future work could explore these relationships explicitly to better understand the roles of organizations. The Leaders in Science Technology and Engagement Networks, or LISTEN Network, launched in 2020 to provide this sort of connectivity "across the science-engagement ecosystem."

6. Recruit and support diverse leadership

> ***"I'm here and have this space. I'm going to use this space that I have to advocate for others, be the representation that I'm trying to make and see. Here's a light, follow me, y'all, let's keep going. Hopefully I [eventually] won't need that little candle because the whole room will be lit."***
>
> ***-ECRC participant***

A truly inclusive framework for science communication requires diverse participation and leadership from individual to institutional scales to enrich the aims and implementation of the work (Eagly & Chin, 2010; Hong & Page, 2004)**, interrogate assumptions about publics** (Soleri et al., 2016)**, provide "visual cues of belonging"** (Pearson and Schuldt, 2014) **and counter singularly Western views and stereotypes of STEMM** (Bang et al., 2018; Cheryan et al., 2013). Approaches for supporting this leadership shift include:

a. Intentional recruitment, support, and retention of leaders, from project to institutional scales, with marginalized and/or intersectional identities;
b. Building diverse teams with expertise that spans multi-modal science communication practice, IDEA expertise, and STEMM research;
c. Practicing reflexivity to ensure that hiring, program design, implementation, evaluation, interactions, and collaborations all reflect the espoused values; and
d. Creating leadership opportunities for students and young professionals to share and experiment with their innovative ISC approaches. These leadership opportunities should not be restricted to ECRC-driven groups but should include ECRC within more influential decision-making bodies.

7. Develop, test, and evaluate ISC curricula and training

In both training settings and in university classrooms, there is a need for more literature, tools, and curricula that train students and practitioners in the foundations, execution, and evaluation of ISC (Dudo, Besley, & Bennett, 2020). The NOVA Science Studio is a helpful model. Even among the individuals interviewed on this project, who, as leaders in the movement, inherently understand the value of this work, there is a concern about insufficient theoretical grounding and practical tools to support inclusive approaches. Some participants communicated a need for more tools to share with colleagues and employees who are interested in doing inclusive science communication but do not know where to start.

a. Recruit and support people with marginalized identities to create, conduct, evaluate, and/or participate in ISC trainings.
b. Develop and offer ISC training at a range of levels, from novice to expert. Both theoretical underpinnings and basic ISC competencies and dispositions, such as active listening, facilitating difficult conversations across difference, empathy, and humility must be explored and practiced (Laman et al., 2012; Miller et al., 2004). The wide-ranging training needs require thoughtful and strategic curriculum development that will combine theory and practice to suit individuals coming from varied backgrounds. For instance, the willingness to develop a reflexive practice was not universal among study participants. Some STEMM researchers and extension leaders desired a list of best practices detailing how to do ISC without developing context-specific goals, relationships, and historical understanding. Personal exploration and reflection are important aspects of ISC (DiAngelo and Sensoy, 2010) and should be incorporated into these training curricula.
c. Incorporate tools and activities to build ISC competencies. The Equity Compass developed by the YESTEM project (YESTEM, 2020), offers an excellent framework for ISC, with a focus on equity-oriented informal science learning. The CAISE Broadening Participation Toolkit is another helpful resource, with conversation guides and practice briefs designed to facilitate reflection (CAISE, 2019).
d. Critically reflect on the end goals of science communication training. Who is served, ultimately, by these trainings? Science communication training can reinforce existing power structures and inequities by preparing communicators to engage powerful, influential audiences (such as policymakers and journalists), rather than communities (Dudo et al., 2020).

8. Develop new, collaborative approaches to evaluation of ISC practice

Interviewees did not offer many comments on evaluation, with one exception: they noted the difficulty of co-creating, implementing, and evaluating ISC work on the timelines and with the budgets funders typically offer. This is addressed further in recommendation 10.

Beyond the funding and time constraints, we also urge the ISC community to explore new, co-created approaches toward evaluation that move beyond simple metrics toward more systematic considerations of impact (Dudo et al., 2020). One such approach from the community engagement field is democratically engaged assessment that maintains rigor while being authentic and inviting full participation (Bandy et al., 2018). This assessment technique aims to operationalize the asset-based approach and key characteristics of ISC rather than defaulting to a top-down approach.

Evaluation also offers a mechanism for dismantling the disciplinary and modal silos currently limiting ISC by leading to novel research questions. (See Appendix 1 for a list of some potential research questions that arose from this study.) The Science Communication Partnership Awards, funded by the Rita Allen Foundation and the Kavli Foundation and managed by the Standing Committee on Advancing Science Communication Research and Practice at the National Academies of Sciences, Engineering and Medicine, are an example of how to explore new collaborations to inform research and practice.

9. Value and validate context-dependent approaches to evolve beyond the binary concepts of "researcher" and "practitioner"

This study identified the value of moving beyond a binary perception by which someone is either a researcher or a practitioner; a binary, it should be noted, that we assumed in the structure of the project. Our interviews included questions asking participants both to self-identify as a researcher or practitioner, and to identify leaders who were either a researcher or practitioner. Participants consistently had difficulty defining themselves and their colleagues as either a researcher or practitioner.

This study found that many leaders in the ISC movement see themselves as a hybrid of both researcher and practitioner along a continuum that may change from situation to situation. Many identified primarily as practitioners but noted that they apply scientific approaches to their practice by researching background information and developing research questions for how to best achieve their intended outcomes.

The recognition of the research/practice continuum is an opportunity to validate and embrace diverse approaches to ISC, since effective research and practice each require some of the other. A more explicit acknowledgement of the practitioner/researcher role could advance the movement and build legitimacy for this multifaceted career path.

10. Funders use their influence to hasten implementation of ISC practices

Science communication professionals can easily default to concerns about available funding. Indeed, this is a real challenge for all science communication work (NASEM, 2017), and it's only exacerbated for inclusive science communication. However, **beyond the basic need for additional support of ISC research and practice, this study highlighted several actions that funders can take to advance the movement**.

1. Validate inclusive science communication by explicitly requiring attention to IDEA and the three key traits of ISC in proposal guidelines.
2. Encourage proposals that bridge disciplines, sectors, and modes.
3. Encourage equitable research/practice collaborations.
4. Support early career communicators by encouraging grantees to substantively engage junior scholars in science communication projects.
5. Emphasize the importance of evaluation to advance ISC based on evidence.
6. Extend project funding timelines and budgets to allow for the relationship building required for equitable engagement and thorough evaluation. In many cases, that relationship building will require some modest financial compensation for participants, even if this is contrary to the funder's typical practices.
7. Acknowledge that science communication, generally, and inclusive science communication, specifically, is a rapidly evolving landscape whose practitioners and researchers hail from diverse professional and educational backgrounds. That diversity of experience and perspective is beneficial, even, perhaps especially, if it represents "non-traditional" forms of expertise.

Conclusion

> ***"You don't have to do everything at once. Sometimes people get discouraged because [they] feel like 'no matter what I do it's not good enough.' Reminding people now and then that as long as you're aware and doing the best you can with the resources you have, you are contributing [to ISC]."***

This study marks the first investigation of motivations, methods, challenges, and pressure points for the inclusive science communication movement. While many of our observations have been noted in previous studies of the component disciplines, this new picture of the ISC landscape offers insights that can prompt a transdisciplinary view of these siloed but largely overlapping efforts. We hope this report can provide a basis for further exploration and experimentation that will dismantle the silos and accelerate the transition toward a new paradigm of science communication that is inclusive and equitable by default.

Acknowledgements

We thank the Kavli Foundation and the Burroughs Wellcome Fund for supporting this work at a critical time in the development of the public engagement and science communication fields, especially Brooke Smith, Eric Marshall, and Russ Campbell, who have been stalwart advocates for inclusion and equity. We are grateful for the insights and guidance of our formal and informal advisors on this project, including Brooke Smith, Bronwyn Bevan, Sonia Zárate, Cristin Dorgelo, Erica Kimmerling, Jennifer Kurzweil, and Mónica Feliú-Mójer.

The interviewees and other participants gave generously of their time to inform this study, and several of them provided feedback on the final report. Thank you. We are grateful to Lisette Torres-Gerald and Christine Liu, who served as “ambassadors” for the project at conferences in 2020 to gather additional perspectives. We also thank Christine Liu for creating figures to summarize the study’s findings. Finally, we note our deep appreciation for all of you who are building this movement and changing science communication for the better.

References

AbiGhannam, N. (2016). Madam Science Communicator: A Typology of Women's Experiences in Online Science Communication. *Science Communication*, 38(4): 468–494.

Ahmed, S. M., Neu Young, S., DeFino, M. C., Franco, Z., & Nelson, D. A. (2017). Towards a practical model for community engagement: Advancing the art and science in academic health centers. *Journal of clinical and translational science*, *1*(5), 310–315. https://doi.org/10.1017/cts.2017.304

Alechine, E. 02 August 2019. "How I switched from academica to science communication." *Nature Career Columns.* doi: 10.1038/d41586-019-02387-w

Allied Media Projects. (2020). https://alliedmedia.org

Alperin, J.P., Muñoz Nieves, C., Schimanski, L.A., et al. (2019, Feb 8). How significant are the public dimensions of faculty work in review, promotion and tenure documents? *Elife*. DOI: 10.7554/elife.42254.

Anderegg, W.R.L. (2010). The Ivory Lighthouse: communicating climate change more effectively. *Climatic Change,* 101**:** 655–662. https://doi.org/10.1007/s10584-010-9929-z

Anila, S. (2017). Inclusion Requires Fracturing, *Journal of Museum Education*, 42(2): 108-119.

Archer, L., Dawson, E., DeWitt, J., Seakins, A., & Wong, B. (2015). "Science capital": A conceptual, methodological, and empirical argument for extending bourdieusian notions of capital beyond the arts. *Journal of Research in Science Teaching*, 52, 922-948.

Association Chat. (2020, September 4). Coronavirus, Comedy, and Fighting Other Monsters. [Podcast] YouTube. https://www.youtube.com/watch?v=DRRFsUIVDvI

Augare, H.J., Davíd-Chavez, D.M., Groenke, F.I., Plume-Weatherwax, M.L., Lone Fight, L., Meier, G., Quiver-Gaddie, H., Returns From Scout, E., Sachatello-Sawyer, B., St. Pierre, N., Valdez, S., & Wippert, R. (2017). A cross-case analysis of three Native Science Field Centers. *Cult Stud of Sci Educ,* 12: 227–253. https://doi.org/10.1007/s11422-015-9720-6

Bäckstrand, K. (2003). Civic Science for Sustainability: Reframing the Role of Experts, Policy-Makers and Citizens in Environmental Governance, *Global Environmental Politics*, MIT Press, 3(4): 24-41.

Bandy, J., Price, M. F., Clayton, P. H., Metzker, J., Nigro, G., Stanlick, S., Woodson, S., Bartel, A., & Gale, S. (2018). “Democratically engaged assessment: Reimagining the purposes and practices of assessment in community engagement.” Davis, CA: Imagining America.

Bang, M., Marin, A., & Medin, D. (2018). If Indigenous peoples stand with the sciences, will scientists stand with us? *Am. Acad. Arts Sci.* 147, 148–159. doi: 10.1162/DAED_a_00498

Banks, J. A., Au, K. H., Ball, A. F., Bell, P., Gordon, E. W., Gutiérrez, K. D., et al. (2007). “Learning in and out of school in diverse environments,” in The LIFE Center and Center for Multicultural Education (Seattle, WA: University of Washington), 36.

Batty, D. (2020 Jul 6). Universities criticised for 'tokenistic' support for Black Lives Matter. The Guardian. https://www.theguardian.com/education/2020/jul/06/universities-criticised-for-tokenistic-support-for-black-lives-matter

Beier, P., Hansen, L.J., Helbrecht, L. & Behar, D. (2017). A How-to Guide for Coproduction of Actionable Science. *Conservation Letters*, 10: 288-296. doi:10.1111/conl.12300

Bell, P., Lewenstein, B., Shouse, A., W., & Feder, M. A. (2009). Learning science in informal environments: People, places, and pursuits. Washington D.C.: The National Academies Press.

Berditchevskaia, A., Regalado, C., & van Duin, S. (2017). The changing face of expertise and the need for knowledge transfer. *Journal of Science Communication*, 16(04 (C03)): 1–8.

Besley, J.C., Dudo, A., & Smith, B. (2017). “Support Systems for Scientists’ Communication and Engagement Workshop I: Communication Training - Landscaping Overview of the North American Science Communication Training Community Report.” https://www.informalscience.org/support-systems-scientists’-communication-and-engagement-workshop-i-communication-engagement

Besley, J.C., Dudo, A., Yuan, S., & Lawrence, F. (2018). Understanding Scientists’ Willingness to Engage. *Science Communication*, 40(5): 559–590.

Besley J.C., O’Hara, K., & Dudo, A. (2019). Strategic science communication as planned behavior: Understanding scientists’ willingness to choose specific tactics. *PLoS ONE,* 14(10): e0224039. https://doi.org/10.1371/journal.pone.0224039

Besley, J. C., Dudo, A. D., Yuan, S., & Abi Ghannam, N. (2016). Qualitative Interviews With Science Communication Trainers About Communication Objectives and Goals. *Science Communication*, 38(3): 356–381.

Bevan, B., Calabrese Barton, A., & Garibay, C. (2018). “Broadening Perspectives on Broadening Participation in STEM.” Washington, DC: CAISE.

Bevan, B., & Smith, B. (2020). Science communication in the USA: It’s complicated. In T. Gascoigne, B. Schiele, J.Leach, M.Reidlinger, B.Lewenstein, L.Massarani, & P. Broks (Eds.), *Communicating Science: A Global Perspective* (pp. 959-982). ANU Press.

Biyela, S. (2019 Feb 12). *Decolonizing science writing in South Africa.* The Open Notebook. https://www.theopennotebook.com/2019/02/12/decolonizing-science-writing-in-south-africa/

Blue, G. (2019). Science Communication Is Culture: Foregrounding Ritual in the Public Communication of Science. *Science Communication*, 41(2): 243–253. https://doi.org/10.1177/1075547018816456

Bonney, R., Phillips, T.B., Ballard, H.L. & Enck, J.W. (2015). Can citizen science enhance public understanding of science? *Public Understanding of Science*, 25(1): 2-16.

Boutte, G. S., & Jackson, T. O. (2014). Race Ethnicity and Education Advice to White allies: insights from faculty of Color. *Race Ethnicity and Education*, 17(5): 623–642.

Bruine de Bruin, W. & Bostrom, A. (2013). Assessing what to address in science communication. *Proceedings of the National Academy of Sciences USA*. 110(Suppl 3):14062-14068. doi:10.1073/pnas.1212729110

Brulle, R.J. (2010). From Environmental Campaigns to Advancing the Public Dialog: Environmental Communication for Civic Engagement, *Environmental Communication*, 4(1): 82-98.

Buolamwini, J. (2018). AI, Ain’t I a Woman? YouTube. https://www.youtube.com/watch?time_continue=21&v=QxuyfWoVV98&feature=emb_logo

Burns, T. W., O’Connor, D. J., & Stocklmayer, S. M. (2003). Science Communication: A Contemporary Definition. *Public Understanding of Science*, 12(2): 183–202.

CAISE. (2019). Broadening Perspectives on Broadening Participation in STEM. A toolkit to support science engagement professionals who are developing strategic efforts to broaden participation in STEM. Center for Advancement of Informal Science Education. https://www.informalscience.org/broadening-perspectives

Calabrese Barton, A., & Tan, E. (2020). Beyond Equity as Inclusion: A Framework of "Rightful Presence" for Guiding Justice-Oriented Studies in Teaching and Learning. *Educational Researcher*, 49(6):433-440.

Canfield, K. N., Menezes, S., Matsuda, S. B., Moore, A., Mosley Austin, A. N., Dewsbury, B. M., Feliú-Mújer, M. I., McDuffie, K. W. B., Moore, K., Reich, C. A., Smith, H. M., & Taylor, C. (2020). Science communication demands a critical approach that centers inclusion, equity, and intersectionality. *Frontiers in Communication*, 5: 2. https://doi.org/10.3389/fcomm.2020.00002

Carlone, H. B., and Johnson, A. (2007). Understanding the science experiences of successful women of color: science identity as an analytic lens. *Journal of Research in Science Teaching*. 44: 1187–1218.

Center for Evaluation Innovation, Institute for Foundation and Donor Learning, Dorothy A Johnson Center for Philanthropy, Luminare Group. "Equitable Evaluation Framing Paper." Equitable Evaluation Initiative, July 2017, www.equitableeval.org.

Center for Scientific Collaboration and Community Engagement. (2020). "A guide to using virtual events to facilitate community-building: Event formats." Woodley, Pratt, Ainsworth, Amsen, Bakker, Butland, O'Donnell, Penfold, Pope, Quigley, & Tsang doi: 10.5281/zenodo.3934385

Cheryan, S., Plaut, V. C., Handron, C., & Hudson, L. (2013). The stereotypical computer scientist: gendered media representations as a barrier to inclusion for women. *Sex Roles* 69: 58–71.

Chesbrough, H. & Spohrer, J. (2006). A research manifesto for services science. *Communications of the ACM*, 49(7). DOI: 10.1145/1139922.1139945

Chilvers, J. (2013). Reflexive Engagement? Actors, Learning, and Reflexivity in Public Dialogue on Science and Technology. *Science Communication*, 35(3): 283–310.

Clark, F. & Illman, D.L. (2001). Dimensions of Civic Science. *Science Communication*, 23(1): 5-27.

Clark, N., Hunt, S., Jules, G., & Good, T. (2010). Ethical dilemmas in community-based research: Working with vulnerable youth in rural communities. *J. Acad. Ethics*. 8: 243-252.

Cobern, W., & Loving, C. (2001). Defining "Science" in a multicultural world: implications for science education. *Sci. Ed*., 85: 50–67.

Cooper, R., Dunn, N., Coulton, P., Walker, S., Rodgers, P., Cruikshank, L., Tsekleves, E., Hands, D., Whitham, R., Boyko, C.T., Richards, D., Aryana, B., Pollastri, S., Lujan Escalante, M.A., Knowles, B., Lopez-Galviz, C., Cureton, P. & Coulton, C. (2018). Imagination Lancaster: Open-ended, antidisciplinary, diverse. *She Ji: The Journal of Design, Economics, and Innovation*, 4(4): 307-341.

Corder, D.M. & Davis, D.L. (2020). Communication for equity in the service of patient experience: Health justice and the COVID-19 pandemic. *Journal of Patient Experience*, 7(3): 279-281.

Crenshaw, K. (1989). *Demarginalizing the Intersection of Race and Sex: A Black Feminist Critique of Antidiscrimination Doctrine, Feminist Theory and Antiracist Politics*. University of Chicago Legal Forum, 139–168.

Crettaz von Roten, F. (2011). Gender Differences in Scientists' Public Outreach and Engagement Activities. *Science Communication*, *33*(1): 52–75.

Daniszewski, J. (2020). Why we will lowercase white. Associated Press. https://blog.ap.org/announcements/why-we-will-lowercase-white

Dawson, E. (2014). Reframing social exclusion from science communication: moving away from 'barriers' towards a more complex perspective. *J. Sci. Commun.* 13:C02. doi: 10.22323/2.13020302

Dawson, E. (2018). Reimagining publics and (non)participation: Exploring exclusion from science communication through the experiences of low-income, minority ethnic groups. *Public Understanding of Science*, 27(7): 772-786.

Dawson, E. (2019). *Equity, Exclusion and Everyday Science Learning: The Experiences of Minoritised Groups*. Oxon, OX; New York, NY: Routledge.

Dawson, E. (2020, July 30). *On necropolitics and science communication*. [Video] PCST Webinar. https://pcst.co/webinars/20200730

Dawson, E. & Streicher, B. (2020). Responding to the pandemic: A social justice perspective. Spokes, 63. Ecsite. https://bit.ly/3nADHkA

Delgado Bernal, D. (2002). Critical Race Theory, Latino Critical Theory, and Critical Raced-Gendered Epistemologies: Recognizing Students of Color as Holders and Creators of Knowledge. *Qualitative Inquiry*, 8(1): 105–126.

Dewsbury, B. & Brame, C. (2019). Inclusive Teaching. *CBE - Life Sciences Education*, 18(2). https://doi.org/10.1187/cbe.19-01-0021

Dostilio, L.D., Harrison, B., Brackmann, S.M., Kliewer, B.W., Edwards, K.E., & Clayton, P.H. (2012). Reciprocity: saying what we mean and meaning what we say. *Michigan Journal of Community Service Learning*, *19*(1): 17-32.

Dilling, L., & Lemos, M.C. (2011). Creating usable science: Opportunities and constraints for climate knowledge use and their implications for science policy. *Global Environmental Change-human and Policy Dimensions,* 21: 680-689.

Dudo, A., Besley, J., & Bennett, N. (2020). Landscape of science communication fellowship programs in North America. https://ritaallen.org/app/uploads/2020/06/SciEng-Fellowships-Report.pdf

Dudo, A., Besley, J.C, & Yuan, S. (2020). Science Communication Training in North America: Preparing Whom to Do What With What Effect? *Science Communication*. doi:10.1177/1075547020960138

Eagly, A.H., & Chin, J.L. (2010). Diversity and leadership in a changing world. *American Pyschologist*, 65(3): 216-224.

Ecklund EH, James SA, Lincoln AE (2012) How Academic Biologists and Physicists View Science Outreach. *PLoS ONE,* 7(5): e36240. https://doi.org/10.1371/journal.pone.0036240

Ecsite. (May 2020). "2019 Annual Report." Available from https://www.ecsite.eu/sites/default/files/annual_report_2019_final_version_0.pdf

Faridi, Z., Grunbaum, J.A., Gray, B.S., Franks, A., & Simoes, E. (2007) Community-based participatory research: necessary next steps. *Prev Chronic Dis*, 4(3). Available from http://www.cdc.gov/pcd/issues/2007/jul/06_0182.htm.

Frank, K. (2017, June 7). Summer dance series integrating science and culture. Frank Laboratory. https://bit.ly/3iQFjD2

Frazier, L.R. (2016). Flint is family. http://www.latoyarubyfrazier.com/work/flint-is-family/

Garbarino, J. (2020). "5. Learning from your mentee." Rockefeller University. https://rockedu.rockefeller.edu/new_outreach/learning-from-your-mentee/

Garibay, C. (2011 Jan/Feb). Responsive and accessible: How museums are using research to better engage diverse cultural communities. ASTC Dimensions, Association of Science and Technology Centers. https://www.astc.org/astc-dimensions/responsive-and-accessible-how-museums-are-using-research-to-better-engage-diverse-cultural-communities/

Ginexi, E.M., Huang, G., Steketee, M., Tsakraklides, S., MacAllum, K., Bromberg, J., Huffman, A., Luke, D.A., Leischow, S.J., Okamoto, J.M, Rogers, T. 2017. Social network analysis of a scientist–practitioner research initiative established to facilitate science dissemination and implementation within states and communities, *Research Evaluation*, 26(4): 316–325.

Glasson, G.E., Mhango, N., Phiri, A. & Lanier, M. (2010). Sustainability Science Education in Africa: Negotiating indigenous ways of living with nature in the third space. *International Journal of Science Education*, 32(1): 125-141.

Goodley, D., Liddiard, K., & Runswick-Cole, K. (2018). Feeling disability: theories of affect and critical disability studies. *Disability & Society*, 33(2): 197-217.

Guerrero-Medina, G., Feliú-Mójer, M., González-Espada, W., Díaz-Muñoz, G., López, M., Díaz-Muñoz, S.L., Fortis-Santiago, Y., Flores-Otero, J., Craig, D., & Colón-Ramos, D.A., (2013). Supporting Diversity in Science through Social Networking. *PLoS Biology*. https://doi.org/10.1371/journal.pbio.1001740

Gollust, S.E., Nagler, R.H., & Fowler, E.F. (2020). The Emergence of COVID-19 in the U.S.: A Public Health and Political Communication Crisis. *J Health Polit Policy Law,* 8641506. doi: https://doi.org/10.1215/03616878-8641506

Gunckel, K. (2009). Queering Science for All: Probing Queer Theory in Science Education. *Journal of Curriculum Theorizing*, 25(2): 62-75.

Hendricks, R. (2020). Scientific societies and civic science: Current landscape and the future. https://www.informalscience.org/scientific-society-civic-science-landscape

Hernández-Saca, D.I., Gutmann Kahn, L., & Cannon, M.A. (2018). Intersectionality Dis/ability Research: How Dis/ability Research in Education Engages Intersectionality to Uncover the Multidimensional Construction of Dis/abled Experiences. *Review of Research in Education*, *42*(1): 286–311.

Hofstein, A., & Rosenfeld, S. (1996). Bridging the Gap Between Formal and Informal Science Learning. *Studies in Science Education*, 28(1): 87-112.

Hong, L., & Page, S.E. (2004). Groups of diverse problem solvers can outperform groups of high-ability problem solvers. *PNAS*, 101(46): 16385-16389.

hooks, b. (1981). *Ain't I a woman: Black women and feminism*. Boston: South End Press

Humm, C., & Schrögel, P. (2020). Science for all? Practical recommendations on reaching underserved audiences. *Frontiers in Communication*, 5: 42. https://doi.org/10.3389/fcomm.2020.00042

Hunt, S. (2015). *Review of Core Competencies for Public Health: An Aboriginal Public Health Perspective*. Prince George, BC: National Collaborating Centre for Aboriginal Health.

Hurtado, S., White-Lewis, D., & Norris, K. (2017). Advancing Inclusive Science and Systemic Change: the convergence of national aims and institutional goals in implementing and assessing biomedical science training. *BMC Proceedings*, 11(Suppl 12): 17.

IFES. (2020). Inclusion Insights: Holding accessible and inclusive virtual meetings. https://bit.ly/2SOaJPS

Ishimaru, A.M., & Galloway, M.K. (2014). Beyond Individual Effectiveness: Conceptualizing Organizational Leadership for Equity. *Leadership and Policy in Schools*, 13(1): 93-146.

Jacobson, S., Seavey, J., & Mueller, R. (2016). Integrated science and art education for creative climate change communication. *Ecology and Society,* 21(3). http://www.jstor.org/stable/26269971

Jensen, E., & Gerber, A. (2020 May 27). For science communication to be effective it should be evidence based. LSE Impact Blog, London School of Economics and Political Science. https://blogs.lse.ac.uk/impactofsocialsciences/2020/05/27/for-science-communication-to-be-effective-it-should-be-evidence-based

Johnson, A. N., Sievert, R., Durglo Sr, M., Finley, V., & Hofmann, M. H. (2014). Indigenous knowledge and geoscience on the Flathead Indian Reservation, Northwest Montana: implications for place-based and culturally congruent education. *J. Geosci. Educ*., 62: 187–202.

Johnson, E. (2019). “Recode decode at TED: Biologist Danielle N. Lee wants “more nerdy black and brown kids,” in STEM. Vox.com. Available online at: http://bit.ly/2GczDmt

Josephson, J. (2018). Teaching Community Organizing and the Practice of Democracy. *Journal of Political Science Education*, 14(4): 491-499.

Jumreornvong, O., Tabacof, L., Cortes, M., Tosto, J., Kellner, C.P., Herrera, J.E. & Putrino, D. (2020). Ensuring equity for people living with disabilities in the age of COVID-19. *Disability & Society*, DOI: 10.1080/09687599.2020.1809350

Kadushin, C. (2012). *Understanding social networks: Theories, concepts, and findings*. Oxford, UK: Oxford University Press

Kearns, F.R. (2015). A relational approach to climate change: Working with people and conflict. In E. Fretz (Ed.), *Climate Change Across the Curriculum,* (pp. 219-234). Lexington Books, Lanham, MD.

Kretzmann, J., & McKnight, J. (1993). *Building Communities from the Inside Out*, Chicago: ACTA Publications.

Ladson-Billings, G. (1998) Just what is critical race theory and what's it doing in a nice field like education?, *International Journal of Qualitative Studies in Education*, 11(1): 7-24.

Laman, T. T., Jewett, P., Jennings, L. B., Wilson, J. L., & Souto-Manning, M. (2012). Supporting critical dialogue across educational contexts. *Equity Excellence in Education*. 45: 197–216.

Langin, K. (2020). "I can't even enjoy this." Black Birders Week organizer shares her struggles as a Black scientist. *Science*. doi:10.1126/science.caredit.abd1901

Latulippe, N., & Klenk, N. (2020). Making room and moving over: Knowledge co-production, Indigenous knowledge sovereignty and the politics of global environmental change decision-making. *Current Opinion in Environmental Sustainability*, 42: 7-14.

Laursen, S. Liston, C., Thiry, H. & Graf, J. 2007. What Good Is a Scientist in the Classroom? Participant Outcomes and Program Design Features for a Short-Duration Science Outreach Intervention in K–12 Classrooms. *CBE—Life Sciences Education,* 6(1): 49-64.

Lavery, J.V. (2018). Building an evidence base for stakeholder engagement. *Science*, 361(6402).

Lee, D.N. (2014 Oct 14). This happened: Science Online is no more. The Urban Scientist, Scientific American. https://blogs.scientificamerican.com/urban-scientist/this-happened-science-online-is-no-more/

Lemus, J.D., Seraphin, K.D., Coopersmith, A. & Correa, C.K.V. (2014). Infusing Traditional Knowledge and Ways of Knowing Into Science Communication Courses at the University of Hawai'i, *Journal of Geoscience Education*, 62(1): 5-10.

Lewenstein, B. (2001). Who produces science information for the public? In J. Falk, E. Donovan, & R. Woods (Eds.), *Free-choice science education: How we learn science outside of schools* (pp. 21–43). New York: Teachers College Press.

Mack, E., Augare, H., Different Cloud Jones, L., David, D., Quiver Gaddie, H., Honey, R. E., et al. (2012). Effective practices for creating transformative informal science education programs grounded in Native ways of knowing. *Cult. Studies Sci. Educ*. 7, 49–70.

Manlove, K.R., Walker, J.G., Craft, M.E., Huyvaert, K.P., Joseph, M.B., Miller, R.S., Nol, P., Patyk, K.A., O'Brien, D., Walsh, D.P, & Cross, P.C. (2016). "One Health" or Three? Publication Silos Among the One Health Disciplines, *PLoS Biology*, DOI: 10.1371/journal.pbio.1002448

Manzini, S. (2003). Effective communication of science in a culturally diverse society. *Science Communication*, 25: 191–197.

Márquez, M.C. & Porras, A.M. (2020). Science communication in multiple languages is critical to its effectiveness. *Frontiers in Communication*, 5: 31. DOI: 10.3389/fcomm.2020.00031

Mathie, A. & Cunningham, G. (2003). From clients to citizens: Asset-based Community Development as a strategy for community-driven development. *Development in Practice*, 13(5): 474-486.

Mathur, V.N., Price, A.D.F., & Austin, S. (2008). Conceptualizing stakeholder engagement in the context of sustainability and its assessment, *Construction Management and Economics*, 26(6): 601-609.

McCarty, T.L., Nicholas, S.E., Chew, K.A.B., Diaz, N.G., Leonard, W.Y., & White, L. (2018). Hear Our Languages, Hear Our Voices: Storywork as Theory and Praxis in Indigenous-Language Reclamation. *Daedalus*, 147(2): 160-172.

McKenzie, L. (2020 Jun 8). Words matter for college presidents, but so will actions. Inside Higher Ed. https://www.insidehighered.com/news/2020/06/08/searching-meaningful-response-college-leaders-killing-george-floyd

Medin, D. L., & Bang, M. (2014). The cultural side of science communication. *PNAS*, 111: 13621–13626.

Meekosha, H. (2011). Decolonising disability: thinking and acting globally, *Disability & Society*, 26(6): 667-682.

Michener, L., Aguilar-Gaxiola, S., Alberti, P.M,, Castaneda, M.J., Castrucci, B.C., Harrison, L.M., Hughes, L.S., Richmond, A., & Wallerstein, N. (2020). Engaging With Communities — Lessons (Re)Learned From COVID-19. *Prev Chronic Dis*, 17:200250.

Miller, J., Donner, S., & Fraser, E. (2004). Talking when talking is tough: Taking on conversations about race, sexual orientation, gender, class, and other aspects of social identity. *Smith College Studies in Social Work* 74: 377–392.

Mock, J. (2020 Jun 1). 'Black Birders Week' promotes diversity and takes on racism in the outdoors. Audubon Magazine. https://www.audubon.org/news/black-birders-week-promotes-diversity-and-takes-racism-outdoors

Moskal, B.M., Skokan, C., Kosbar, L., Dean, A., Westland, C., Barker, H., Nguyen, Q.N. & Tafoya, J. (2007). K-12 Outreach: Identifying the Broader Impacts of Four Outreach Projects. *Journal of Engineering Education*, 96: 173-189.

Museum of Science, Boston. (2019 Feb 8). Museum of Science, Boston leads national project to bridge gap between science and community. https://www.mos.org/press/press-releases/CCPES

National Academies of Sciences, Engineering, and Medicine. (2017). *Communicating Science Effectively: A Research Agenda*. Washington, DC: The National Academies Press. https://doi.org/10.17226/23674.

National Science Foundation (2014). Science & Engineering Indicators. http://www.nsf.gov/statis- tics/seind14/content/etc/nsb1401.pdf.

NIFA. (2020). "Extension."United States Department of Agriculture, National Institute of Food and Agriculture. https://nifa.usda.gov/extension

NOVA. (2019 Jan 30). "Introducing: NOVA Science Studio." PBS. https://www.pbs.org/wgbh/nova/article/introducing-nova-science-studio/

Orthia, L. (2020). Strategies for including communication of non-Western and indigenous knowledges in science communication histories. *Journal of Science Communication*, 19(02)A02.

Pandya, R.E. (2014). "Community-Driven Research in the Anthropocene. In Future Earth—Advancing Civic Understanding of the Anthropocene." (eds D. Dalbotten, G. Roehrig & P. Hamilton). doi:10.1002/9781118854280.ch6

Patrizi, P., & McMullan, B. (1998 Dec). EVALUATION IN FOUNDATIONS: The Unrealized Potential. Prepared for the W.K. Kellogg Foundation Evaluation Unit. http://www.wkkf.org/~/media/0E11D0D4CA604FFC93594C3AE9E68EF7.ashx

Pearson, A., Ballew, M., Naiman, S., & Schuldt, J. (2017). Race, class, gender and climate change communication. *Oxford Research Encyclopedia of Climate Science*. https://oxfordre.com/climatescience/view/10.1093/acrefore/9780190228620.001.0001/acrefore-9780190228620-e-412

Philip, T.M., Bang, M. & Jackson, K. (2018). Articulating the "How," the "For What," the "For Whom," and the "With Whom" in Concert: A Call to Broaden the Benchmarks of our Scholarship, *Cognition and Instruction*, 36(2): 83-88.

Polk, E. & Diver, S. (2020). Situating the scientist: Creating inclusive science communication through equity framing and environmental justice. *Frontiers in Communication*, 5: 6. https://doi.org/10.3389/fcomm.2020.00006

Poor, W. (2018 Dec 11). How deaf researchers are reinventing science communication. *Vox.com*. https://www.theverge.com/science/2018/12/11/18133033/science-asl-american-sign-language-jargon-communication

Ramirez-Andreotta, M. D., Brusseau, M. L., Artiola, J., Maier, R. M., & Gandolfi, A. J. (2015). Building a co-created citizen science program with gardeners neighboring a superfund site: The Gardenroots case study. *International public health journal*, *7*(1): 13.

Rasekoala, E. (2019). The seeming paradox of the need for a feminist agenda for science communication and the notion of science communication as a 'ghetto' of women's over-representation: perspectives, interrogations and nuances from the global south. *Journal of Science Communication*, 18(4): C07.

Ray, V. (2019 Nov 19). "Why so many organizations stay white." Harvard Business Review. https://hbr.org/2019/11/why-so-many-organizations-stay-white

Reed, P. (2013). Hashtags and retweets: using twitter to aid community, communication, and casual (informal) learning. *Research in Learning Technology,* 21: 1–21.

Richard, G. (2013). Designing Games That Foster Equity and Inclusion: Encouraging Equitable Social Experiences Across Gender and Ethnicity in Online Games. In G. Christou, E. Lai-Chong Law, D. Geerts, L.E. Nacke, & P. Zaphiris (Eds.), *Proceedings of the CHI'2013 Workshop: Designing and Evaluating Sociability in Online Video Games*, (pp. 83-88).

Richard, G.T., & Giri, S. (2017). Inclusive collaborative learning with multi-interface design: Implications for diverse and equitable makerspace education. In B. K. Smith, M. Borge, E. Mercier, & K. Y. Lim (Eds.), *Making a Difference: Prioritizing Equity and Access in CSCL - 12th International Conference on Computer Supported Collaborative Learning, CSCL 2017 - Conference Proceedings* (pp. 415-422). (Computer-Supported Collaborative Learning Conference, CSCL; Vol. 1). International Society of the Learning Sciences (ISLS).

Riedlinger, M., Massarani, L., Joubert, M., Baram-Tsabari, A., Entradas, M., & Metcalfe, J. (2019). Telling stories in science communication: Case studies of scholar-practitioner collaboration. *Journal of Science Communication*, 18(5). DOI: 10.22323/2.18050801

Rodríguez Estrada, F. C., & Davis, L. S. (2015). Improving Visual Communication of Science Through the Incorporation of Graphic Design Theories and Practices Into Science Communication. *Science Communication*, *37*(1), 140–148. https://doi.org/10.1177/1075547014562914

Root Cause Research Center. (2020). https://www.rootcauseresearch.org/about

Rosin, M., Wong, J., O'Connell, K., Storksdieck, M., & Keys, B. (In press). Guerilla Science: Mixing science with art, music and play in unusual settings. *Leonardo Music Journal*. doi.org/10.1162/leon_a_01793

Russell, C. (2011 Jan 18). The hottest thing in science blogging. The Observatory, Columbia Journalism Review. https://archives.cjr.org/the_observatory/the_hottest_thing_in_science_b.php

Safford, H.D., Sawyer, S.C., Kocher, S.D., Hiers, J.K., & Cross, M. (2017), Linking Knowledge to Action. *Frontiers in Ecology and the Environment*, 15(10): 560-568.

Salmon, R.A., Priestley, R.K., & Goven, J. (2017). The reflexive scientist: An approach to transforming public engagement. *Journal of Environ Stud Sci*. 7(1): 53-68.

Salmon, R., & Roop, H. (2019). Bridging the gap between science communication practice and theory: Reflecting on a decade of practitioner experience using polar outreach case studies to develop a new framework for public engagement design. *Polar Record, 55*(4): 297-310.

Saltmarsh, J., Hartley, M., & Clayton, P. H. (2009). Democratic engagement white paper. Boston: New England Resource Center for Higher Education.

Sanchez-Hucles, J.V., & Davis, D.D. (2010). Women and women of color in leadership: Complexity, identity, and intersectionality. *American Pyschologist*, 65(3): 171-181.

Sawe, N., Chafe, C., & Treviño, J. (202). Using data sonification to overcome science literacy, numeracy, and visualization barriers in science communication. *Frontiers in Communication*, 5: 46. https://doi.org/10.3389/fcomm.2020.00046

Schell, C.J., Guy, C., Shelton, D.S., Campbell-Staton, S.C., Sealey, B.A., Lee, D.N., & Harris, N.C. (2020). Recreating Wakanda by Promoting Black Excellence in Ecology and Evolution. *Nature Ecology & Evolution*, 4(10): 1285-1287.

Schell, C.J., Dyson, K., Fuentes, T.L., Des Roches, S., Harris, N.C., Miller, D.S., Woelfle-Erskine, C.A., & Lambert, M.R. (2020). The Ecological and Evolutionary Consequences of Systemic Racism in Urban Environments. *Science*. DOI: 10.1126/science.aay4497

Scheufele, D.A., Corley, E.A., Shih, T-j., Dalrymple, K.E., & Ho, S.S.. (2009). Religious beliefs and public attitudes to nanotechnology in Europe and the United States. *Nature Nanotechnology* 4: 91–94.

SciComm Trainers Network. (2020, Jan). *Our Community Charter.* https://www.sctn.online/charter/

Shimmin, C., Wittmeier, K. D. M., Lavoie, J. G., Wicklund, E. D., & Sibley, K. M. (2017). Moving towards a more inclusive patient and public involvement in health research paradigm: the incorporation of a trauma-informed intersectional analysis. BMC Health Serv. Res., 17:539.

Scottish Government (2011). *Principles of Inclusive* Communication: *An Information and Self-Assessment Tool for Public Authorities*. Edinburgh.

Shiose, T., Kagiyama, Y., Toda, K., Kawakami, H., & Katai, O. (2010). Expanding awareness by inclusive communication design. *AI Soc.* 25: 225–231.

Simis, M. J., Madden, H., Cacciatore, M. A., & Yeo, S. K. (2016). The lure of rationality: why does the deficit model persist in science communication? *Public Understand. Sci*. 25, 400–414.

Scheufele, D. A. (2013 Aug). Communicating science in social settings. *Proceedings of the National Academy of Sciences,* 110(Supplement 3): 14040-14047.

Scicomm Trainers Network. 2020. About Us. https://www.sctn.online/about-us/

Science Museum of Minnesota. 2020. "IDEAL CENTER." https://www.smm.org/ideal-center

Simon, N. (2010). "The Participatory Museum." Santa Cruz, Museum 2.0.

Smith, H., Menezes, S., Canfield, K. Guldin, R., Morgoch, M., & McDuffie, K. (2020). Moving toward inclusion: Participant responses to the Inclusive SciComm Symposium. *Frontiers in Communication*, 4. DOI: 10.3389/fcomm.2019.00077

Smith, L. T. (1999). *Decolonizing methodologies: Research and Indigenous peoples*. London: Zed Books.

Soleri, D., Long, J., Ramirez-Andreotta, M., Eitemiller, R., & Pandya, R. (2016). Finding pathways to more equitable and meaningful public-scientist partnerships. *Citizen Science: Theory and Practice*, 1(1): 9.

Stilgoe, J., Lock, S. J., & Wilsdon, J. (2014). Why should we promote public engagement with science? Public Understanding of Science, 23(1): 4–15.

Storksdieck, M., Bevan, B., Risien, J., Nilson, R., & Willis, K. (2018). *Charting the Intersection of Informal STEM Education and Science Communication: Results of a Social Network Study.* Washington, DC: Center for Advancement of Informal Science Education.

Streicher, B., Unterleitner, K., and Schulze, H. (2014). Knowledge rooms—science communication in local, welcoming spaces to foster social inclusion. *J. Sci. Commun.* 13:2014. doi: 10.22323/2.13020303

Suldovsky, B., McGreavy, B., & Lindenfeld, L. (2018). Evaluating Epistemic Commitments and Science Communication Practice in Transdisciplinary Research. *Science Communication*, *40*(4), 499–523.

Taylor, D. E. (2014). The State of Diversity in Environmental Organizations. Green 2.0 Working Group.

The Learning Center for the Deaf. (2020). ASL Clear. https://www.tlcdeaf.org/asl-clear

Trench, B. (2008). "Towards an analytical framework of science communication models," in Communicating Science in Social Contexts, eds D. Cheng, M. Claessens, T. Gascoigne, J. Metcalfe, B. Schiele, and S. Shi. (Eds.) *Communicating science in social contexts: new models, new practices*. Springer Netherlands, pp. 119-138. ISBN 978-1-4020-8597-0

Treffry-Goatley, A. (2014). Communicating Science for social inclusion and political engagement: 449 reflections on the PCST Conference. *J. Sci. Commun.,* 13:R01. doi: 10.22323/2.13030601

Two Photon Art. (2017). Neuroscientist Portrait Project. https://twophotonart.com/pages/freebies

von Wehrden, H., Guimarães, M.H., Bina, O., Varanda, M., Lang, D.J., John, B., Gralla, F., Alexander, D., Raines, D., White, A., & Lawrence, R.J. (2019). Interdisciplinary and transdisciplinary research: finding the common ground of multi-faceted concepts. *Sustain Sci,* 14: 875–888.

Whyte, K.P. (2017). Indigenous Climate Change Studies: Indigenizing Futures, Decolonizing the Anthropocene. *English Language Notes* 55 (1-2): 153-162.

YESTEM Project (2020) The Equity Compass: YESTEM Project Insight #1. http://yestem.org

Yi, F., & Baumann, M. (2018). Guiding principles for designing an accessible, inclusive, and diverse library makerspace. ISAM 2018, International Symposium on Academic Makerspaces, Stanford, CA. https://doi.org/10.18130/v3-7tdc-rm43

Yong, E. (2018 Feb 6). "I Spent Two Years Trying to Fix the Gender Imbalance in My Stories". *The Atlantic.*

Young Landis, B., Bajak, A., de la Hoz, J.F., González, J.G., Gose, R., Pineda Tibbs, C., & Oskin, B. (2020). CómoSciWri: Resources to help science writers engage bicultural and bilingual audiences in the United States. *Frontiers in Communication,* 5: 10. https://doi.org/10.3389/fcomm.2020.00010d

Zax, K. (2014 Mar 14). "#BlackandSTEM: The Hashtag as Community." Fastcompany.com https://www.fastcompany.com/3027122/blackandstem-the-hashtag-as-community

Appendix 1: Research questions for advancing the field

These questions were identified by study participants or are offered in response to issues raised throughout the study.

Early-career researchers and communicators

- What are the qualitative and quantitative effects of early-career researchers' and communicators' involvement and/or leadership in ISC?
- To what degree do academic advisors, supervisors, and administrators support science communication activities among their advisees or junior faculty?

Evaluation

- When practiced in tandem, how do the ISC key traits of intentionality, reciprocity and reflexivity affect outcomes?
- What do synthetic analyses of ISC demonstrate in terms of additional promising practices and research gaps?
- Is the ISC movement growing at different rates within different sectors or modes? If so, can those more advanced sectors or modes be used as models in different settings?

Institutional support and resistance

- Are there less obvious institutional barriers to ISC that need to be identified and addressed?
- What kinds of institutional structures or systems support ISC (in contrast to exploring institutional barriers)?

Networking

- How can organizations most effectively serve as bridges to connect siloed ISC communities?

Structural change

- Who is funding ISC in governmental and private sectors, across the relevant disciplines, sectors, and modes?
- Are there existing examples of structural change related to shifting organizational culture and values in science communication? How can those examples inform efforts to more broadly embed ISC?

- Do specific practices or institutional infrastructures make ISC more sustainable at the organizational level?

Training

- What are the most effective approaches within formal educational curricula and professional development settings to build ISC competencies and skills?
- To what degree do formal curricula and/or training programs affect ISC outcomes?

Appendix 2: Considerations about the Terminology of "Inclusive Science Communication"

Overall, interviewees agreed that the term "inclusive science communication" is appropriate to describe the goals of the movement, at least for now. Many participants acknowledged the possibility that better terminology may exist to describe the movement in different contexts, and that the term may shift as the movement matures.

Already, the language describing this work varies geographically. In Europe, the term "socially inclusive science communication" has been used to specify a focus on including people from historically underrepresented racial and class identities (Dawson, 2014; Streicher, 2014; Treffey-Goatley, 2014), with "inclusive communication" referring more specifically to disability-focused science and health communication efforts (Shiose et al., 2010; Scottish Government, 2011).

Many interviewees noted their hope that, someday, the "inclusive" qualifier would not be needed because of a paradigm shift in which all science communication is inclusive. As that is not currently the case, however, interviewees found it important to explicitly name the focus on inclusion.

Alternative terms for the movement shared by study participants included:

- Science for everyone
- Authentic science engagement
- Equitable science collaboration
- Equitable science communication
- Inclusive science
- SciCommUnity.

Appendix 3: Glossary

Asset-based: techniques, attitudes, and behaviors that value individuals' cultural knowledge and lived experiences as assets rather than deficiencies to be overcome

DEI: an acronym describing work related to Diversity, Equity, and Inclusion

Diversity: the unique experiences and expertise people of varied social identities bring to science and science communication spaces

Equity: remedying societal imbalances in access to power, education, information, or resources by prioritizing opportunities and offering support as needed for those with the least extant access

IDEA: an acronym describing work related to Inclusion, Diversity, Equity, and Access

IDEAL: an acronym describing work related to Inclusion, Diversity, Equity, Access and Leadership

Inclusion: the practice of providing equal access to opportunities and resources for people who might otherwise be excluded or marginalized and creating environments that are welcoming and collaborative for all

Inclusive Science Communication (ISC): a broad term encompassing diverse approaches to engaging publics in STEMM that embraces varied forms of expertise and ways of knowing and expands a sense of belonging in STEMM, particularly for those who have been historically marginalized, through intentional, reciprocal, and reflexive practices

Intersectionality: each person's individual characteristics (e.g., gender, race, physical ability) overlap with one another, creating interdependent systems of oppression or discrimination. These overlapping identities affect a person's status and experiences in the world. (See Crenshaw, 1989; Shimmin et al., 2017)

JEDI: an acronym describing work related to (Social) Justice, Equity, Diversity, and Inclusion

Mode: the specific settings and methods used to engage audiences, such as social media, after school programs, museum exhibits, maker spaces, podcasts, news articles, community-engaged research, etc.

Science communication: any information exchange designed to engage specific audiences in conversations or activities related to STEMM topics